74-6954

ECKERT, Richard Edward, 1943-
ASSOCIATIVE INTERFERENCE IN THE RETENTION OF FREQUENCY INFORMATION.

The University of Oklahoma, Ph.D., 1973
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

ASSOCIATIVE INTERFERENCE IN THE RETENTION OF FREQUENCY INFORMATION

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

RICHARD E. ECKERT

Norman, Oklahoma

1973

ASSOCIATIVE INTERFERENCE IN THE RETENTION

OF FREQUENCY INFORMATION

APPROVED BY

DISSERTATION COMMITTEE

ASSOCIATIVE INTERFERENCE IN THE RETENTION

OF FREQUENCY INFORMATION

by: Richard E. Eckert

Major Professor: N. Jack Kanak

Two experiments were conducted to determine if retention judgments of word presentation frequency were affected by experience with prior or subsequent word presentation frequency information. It was hypothesized that incidentally learned associations were established between frequency and the total environmental context in which it was experienced and that these frequency-context associations may proactively and retroactively interfere with the retention of other frequency information.

The proactive and retroactive experimental and control groups constituted the four major groups in both experiments. The experimental groups were shown two different lists of words while the control groups were shown one list of words and required to perform a number cancellation task either before or after presentation of the critical list. Half of the subjects in each major group were administered their tasks in either same or different experimental contexts. Half of these in turn were given a frequency judgment retention task in either the same context in which the critical list (the list ultimately tested) was presented or in a different context. With respect to the contextual variables, lesser amounts of both types of inhibition were expected in the experimental groups when: 1) the context in which the two lists were presented was different and the judgment context was the same as that in which the critical list was presented; or 2) the context in which the two lists was presented was the same and the judgment context was different.

The first experiment, which required comparative judgments of frequency yielded data indicating proactive and retroactive inhibition, but contextual manipulations were not responsible for the observed judgment decrements. The second experiment, which required absolute judgments of frequency, again indicated retroactive and proactive inhibition. Moreover, the contextual manipulations produced frequency judgment decrements consistent with the hypothesized interaction with the presentation context and judgment context manipulations. The data were discussed with respect to their implications for verbal discrimination transfer and retention and the frequency theory of verbal discrimination learning.

ACKNOWLEDGMENTS

The author would like to especially thank Dr. N. Jack Kanak, Committee Chairman, for his help in the preparation of this dissertation. Appreciation is also extended to the other committee members, Drs. Roger Mellgren, Robert Weiss, John Lamberth and Larry Toothaker for their helpful suggestions and criticisms. All of the mentioned professors have provided unselfish counsel in numerous matters throughout my graduate education at the University of Oklahoma, for which the author is extremely grateful.

A special debt of gratitude is owed to my wife, Barbara J. Eckert, for the typing of this dissertation. Finally, the author would like to thank his son Steve for his patience, understanding and sacrifice.

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ASSOCIATIVE INTERFERENCE IN THE RETENTION

OF FREQUENCY INFORMATION

INTRODUCTION

When performance on a verbal discrimination transfer list composed of old wrong (W) items and new right (R) items (W_1-R_1, W_1-R_2) is compared to performance on a transfer list composed of new W and R items (W_1-R_1, W_2-R_2 nonspecific transfer control) a net negative transfer effect is obtained whether mixed lists (Kausler & Dean, 1967) or unmixed lists are used (Kanak & Dean, 1969; Underwood, Jesse & Ekstrand, 1964). However, the frequency theory of verbal discrimination learning (Ekstrand, Wallace & Underwood, 1966) predicts a decrement in performance at some point in second list learning due to the theoretical equalization of frequency to the W and R items making Rule 2 application inappropriate before Rule 1 application ultimately becomes appropriate. This decrement has not been observed in the W_1-R_2 paradigm (Kanak & Dean, 1969; Kausler & Dean, 1967; Underwood et al., 1964) nor in the theoretically equivalent item function reversal task (Underwood & Freund, 1970; Underwood, Shaughnessy & Zimmerman, 1972). While there has been considerable speculation regarding the reasons for the failure to observe the predicted decrement, Hintzman and Block (1971) have reported data which suggest that frequency information is temporally specific and as such permits the subject (S) to actively ignore the frequency information gained in a previous temporal context. These authors state that Ss are able to discriminate recent from remote frequencies of the same word and in the W_1-R_2 or reversal task come to ignore the more remote frequency information, thus mitigating the expected decrement. While the Hintzman and Block (1971) data are quite convincing with respect to S's ability to discriminate recent from remote frequency information, the interpretation that Ss come to actively ignore the information when the task demands it may not represent a completely accurate account of the processes involved. For instance, it is likely that frequency information is not perfectly transferred from one task to another because some of the information is forgotten. If the frequency of a verbal unit comes to be associated with a temporal or experimental context, then one might assume that contextual sources of associative interference are responsible for the forgetting.

In the original statement of the frequency theory of verbal discrimination (Ekstrand, Wallace & Underwood, 1966) no precise provision was made for the forgetting of a discrimination. To more adequately account for forgetting in verbal discrimination, a frequency-assimilation hypothesis was advanced by Underwood and Freund (1970). This hypothesis holds that frequency produced experimentally (situational frequency) begins to merge with pre-experimental frequency (background frequency) with the passage of time to produce decrements in retention. Basic tests of deductions from the frequency-assimilation hypothesis of forgetting have been undertaken in experiments employing recall, relearning and matching tests (Underwood & Freund, 1970) and in an experiment requiring the comparative judgment of frequency (Underwood, Zimmerman & Freund, 1971). The data obtained from the experiments employing the more traditional retention measures (Underwood & Freund, 1970) generally conform to deductions from the frequency-assimilation hypothesis while the data obtained from an experiment requiring the comparative judgment of frequency (Underwood et al., 1971) do not. While this discrepancy could be due to any number of reasons (i.e. faulty deductive reasoning, insensitive measurement or artifactual results) it could indicate that factors other than frequency or which combine with frequency operate to produce the relationships expected on the basis of frequency alone. Since there is ample data indicating that situational frequency is a dominant factor in recognition memory (e.g., Underwood & Freund, 1968), a conservative evaluation of this discrepancy would be that other factors operate in combination with frequency to produce forgetting. Hence it is postulated here that associative factors operate to influence the retention of frequency information. Specifically, it is assumed that the frequency information gained in one task comes to be incidentally associated with the total stimulus context and that the experience of prior or subsequent frequency information in a similar context interferes with the retention of the tested frequency information.

There is considerable published data which would appear to support the advancement of the present hypothesis. Bilodeau and Schlosberg (1951) and Greenspoon and Ranyard (1957) have shown that the learning of two paired-associate lists in the same experimental context produce greater retroactive interference than if the lists are learned in very different experimental contexts. The interpretation of these data is that the list associations formed during learning enter into further associations with the experimental context. Therefore if the lists are learned in the same or at least in a very similar context, the contextual associations would come to interfere with retention in a manner that is analogous to the A-B, A-C transfer paradigm (A representing the common context and B and C representing the specific associations formed in list-1 and list-2, respectively). If this type of interpretation is to be considered viable, then one should find a contextual source of interference present in the A-B, C-D nonspecific transfer control paradigm. McGovern (1964), in agreement with this expectation, found recall of first list responses to first list stimuli in the A-B, C-D paradigm to be poorer than the corresponding recall in a normal forgetting control group. Moreover, Kanak and Curtis (1970) and Kanak, Cole and Curtis (1972) extended this reasoning to account for a component of interference in the W_1-R_1, W_2-R_2 verbal discrimination nonspecific transfer control paradigm. All of these data appear to support the assumption that the retention of frequency information is subject to the same rules which govern the retention of associations in the paired-associate and verbal discrimination tasks.

It should be noted that the typical procedures used to measure retention in the paired-associate and verbal discrimination tasks (i.e. relearning, recognition, aided recall and free recall) cannot be used to measure the retention of frequency information. However, comparative and absolute judgments of frequency do have characteristics in common with the more traditional retention tasks (e.g., recognition and modified free recall tasks, respectively). The comparative judgment task is similar to the traditional recognition task in which the S must respond concerning the occurrence or nonoccurrence of a word in a previously administered list. In the comparative judgment of frequency, the S is asked to determine which item occurred more often in a previous list. Both the comparative judgment and recognition tasks involve a conditional discrimination on the part of the S. The recognition task requires the S to respond "yes" if a word occurred in a prior list and to respond "no" if it didn't appear. Likewise, in the comparative judgment of frequency, the S is required to indicate the word which occurred more often and not required to indicate it if it appeared less often. The only difference in the two tasks is that in one the S is required to recognize words while in the other the S is required to recognize frequency. On the other hand, the absolute judgment of frequency is conceptually similar to the modified free recall task. In both the absolute judgment and modified free recall tasks the S is required to make a response in the presence of some associated stimulus word. In the case of the modified free recall task the S writes the response word and in the case of absolute judgment the S writes the number of times he believes the stimulus word has occurred.

The purpose of the present experiments was to test the associative hypothesis using comparative and absolute judgments of frequency in retroactive inhibition (RI) and proactive inhibition (PI) paradigms following exposure to the materials of two lists in same or different contexts. Furthermore, since Greenspoon and Ranyard (1957) have also shown that the recall of associations is affected by the retention context, the Ss in these experiments were required to make their frequency judgments in either the same context in which the critical list was presented or in a different context. If the foregoing assumptions are correct, then

RI and PI should occur. Furthermore, with respect to the contextual variables, lesser amounts of both types of inhibition should occur in the experimental groups when: 1) the context in which the two lists are presented are different and the judgment context is the same as that in which the critical list is presented; or 2) the context in which the two lists are presented is the same and the judgment context is different. Finally, with respect to the control groups, better performance should be exhibited by Ss who make their frequency judgments in the same context in which the single list is presented. The first experiment represents a test of the associative hypothesis using the comparative judgment of frequency and the second experiment represents a test of the hypothesis using the absolute judgment of frequency.

Experiment I

Method

Subjects and Design. The Ss were 192 introductory psychology students at the University of Oklahoma who participated as a part of the course requirement. The Ss were randomly assigned to treatment conditions upon arrival at the laboratory. The PI and RI experimental and control groups constituted the four major groups in the experiment. Half of the Ss in each major group were administered their tasks in either same or different experimental contexts. Half of these in turn were given their comparative judgment task in either the same context in which the critical list (the list ultimately tested) was presented or in a different context. The critical list was of course the second list presented to Ss in the PI experimental group and the first list presented to Ss in the RI experimental group. For purposes of clarity in exposition, the designations SS, SD, DS and DD will be used hereafter to refer to the contextual treatment combinations, where the first letter indicates the presentation context (same or different) and the second letter the judgment context (same or different).

In addition to these sixteen treatment conditions, a number of control precautions were exercised through counterbalancing. Half the Ss in each treatment condition were administered either of two critical lists differing in item content which in turn were completely crossed with respect to two rooms in which the critical lists were administered. Furthermore, two serial orders were completely crossed with respect to the two different lists, but random with respect to the rooms.

Contexts. The context in this experiment was manipulated by the use of two different presentation and/or judgment settings. The first room measured 18 ft x 12 ft x 10 ft. This room contained two bookcases, two desks, two wastepaper baskets, a hard wooden chair for S and a table upon which a memory drum was situated. The table and chair were placed in the center of the room away from the walls. The bookcases contained large quantities of printed matter and papers were strewn about on the desks and the floor. Other irrelevant visual stimuli were contained in the room in the form of posters, maps and calendars. This room was well illuminated by ceiling fluorescent lamps and the temperature was held constant at 76°F.

The second room also measured 18 ft x 12 ft x 10 ft, but it was partitioned into an 8 ft x 5 ft x 10 ft cubicle by means of three large bookcases. This cubicle contained only a padded chair and a small table. A small table lamp and a memory drum were the only articles present on the table. The room walls which were visible were bare and the backs of bookcases formed the remaining walls of the cubicle. The partitioned area was poorly illuminated with a single 25 watt incandescent bulb desk lamp focused on the memory drum. The temperature was held constant at 68°F.

Lists. Thirty-six words of AA frequency were chosen from the Thorndike-Lorge (1944) norms for use in the experiment. All of the words were nouns which ranged in length from 4 to 7 letters. In as much as could be determined the words were fairly homogeneous with respect to imagery (Paivio, Yuille & Madigan, 1968) and were not associatively related (Palermo & Jenkins, 1964). Half the words were randomly assigned to list-A and half to list-B. Six of the words in each list were then randomly selected to appear 6 times, 6 to occur 4 times and 6 to occur 2 times, making a total of 72 discrete presentations in each list. The order of the words within a list was random with the restriction that repetitions of a given word be separated by at least two different words. In addition to the two different lists, two serial orders of each list were constructed.

Apparatus and Judgment Materials. A memory drum programmed for a 2 sec rate was used to present the words in both contexts. The comparative judgments of frequency were made on a sheet of paper containing 12 word pairings which represented each word from the appropriate list only once and six words which did not occur in any of the lists. Words having equal situational frequency were not paired, however, every frequency (0, 2, 4 and 6) was paired with every other frequency twice. Adjacent to each pairing was a confidence rating scaled from 1 to 5 in which the S could indicate the degree of confidence in the choice that was made.

Procedure. Preceding the presentation of the lists, Ss were instructed to view and pronounce each word. They were told that some words were repeated in the list and to try to remember all of the words. No information was given concerning the nature of the retention task. After the presentation of the first list, Ss in the inhibition experimental groups viewed a second list 30 sec later in either the same room or the different room. The interlist interval was held constant at 30 sec for Ss in the same context condition so that the interlist interval for Ss who had to change rooms was equal. The instructions for the second list were essentially the same as the first list instructions and required approximately 15 sec to deliver. The maximum amount of time required to change rooms was 15 sec. Following the presentation of the second list the inhibition experimental groups received the comparative judgment task in either the same context in which the critical list was presented or in a different context. The intertask interval was held constant at 40 sec for all conditions. This interval was longer than the interlist interval because questions from Ss were anticipated.

The Ss in the inhibition control groups received essentially the same treatment as outlined above except that a number cancellation task either preceded or succeeded the presentation of the critical list depending upon whether PI or RI control groups were involved. The control Ss performed the number cancellation activity for an interval equal to the interval required by experimental group Ss to view a single word list (144 sec). The intertask intervals for the control groups were equal to those of the experimental groups.

For the comparative judgment task, all Ss were told to circle the word in a pair which they thought occurred more frequently and to make a rating of confidence for that judgment before proceeding to the next pair of words. With respect to the confidence rating, the Ss were told that 5 meant they were absolutely certain that the word they circled occurred more frequently, that 1 meant absolute uncertainly and that 2, 3 and 4 represented varying degrees of confidence between those two extremes. For Ss who were presented only one list, it was evident that the words were taken from it. However, Ss who were presented two lists were told that the words represented on the judgment task were from only one of the lists they viewed.

Results

Errors. A 2 (RI vs PI Groups) x 2 (Experimental vs Control Groups) x 2 (Presentation Contexts) x 2 (Judgment Contexts) between group analysis of variance was performed on the errors made in the comparative judgments of frequency. Significantly more errors were made by the Experimental Groups than by the Control Groups F (1,176)=24.54, p <.001. The means and standard deviations for the Experimental and Control Groups were 1.96, 1.21 and 1.18, .940, respectively. No other significant main effects or interactions were obtained.

Confidence Ratings. The same between groups analysis of variance was performed on the average confidence ratings which were calculated from each S's protocol. The analysis of this measure once again indicated a significant difference between the Experimental Groups and Control Groups F (1,176)=14.00, p=.0005, indicating greater confidence in judgment displayed by the Control Groups. The means and standard deviations for the Experimental and Control Groups were 3.87, .577 and 4.16, .455, respectively.

Once again, however, no other main effects or interactions were significant.

Experiment II

The second experiment was identical in every respect to the first experiment except that Ss were asked to make absolute judgments of frequency. This experiment was undertaken because the absolute judgment task represents another way of assessing the hypothesis previously advanced and represents a task which is more similar to the traditional measures of associative strength (e.g. modified free recall task). Because of the somewhat different nature of the absolute judgment task, a 60 sec interval preceded the judgment task to allow more time for instructions and to answer questions from Ss about the task.

Judgment materials. The Ss in this experiment were asked to make their absolute judgments of frequency on two sheets of paper which contained the 24 words used in the first experiment. Next to each word, space was provided for the Ss to write their frequency estimates and to make confidence ratings concerning their judgments. The Ss were also instructed to use a cover card provided by E in this experiment. A 3 in x ½ in rectangular opening was cut into the cover card which permitted the S access to only one word at a time. The cover card was used to insure that elements of comparative judgment would be minimal in the absolute judgment task.

Results

Absolute deviations. The absolute deviations from actual frequency of occurrence were calculated for each word and then summed to provide a score for each S. A 2 (RI vs PI Groups) x 2 (Experimental vs Control Groups) x 2 (Presentation Contexts) x 2 (Judgment Contexts) between groups analysis of variance was then performed on these deviation scores. This analysis indicated that the Control Groups were more accurate in their judgments than the Experimental Groups $\underline{F}$ (1,176)=26.72, $\underline{p} < .0001$. The means and standard deviations for the Experimental and Control Groups were 30.45, 7.57 and 25.32, 5.53, respectively. The Experimental Control x Presentation Context x Judgment Context interaction was significant and the means and standard deviations for this interaction are represented in Table 1. Newman-Keuls comparisons conducted on the interaction means showed that the Experimental Groups DS and SD did not differ, but that they displayed significantly greater accuracy in judgment than the SS and DD Experimental Groups ($\underline{p}$'s $< .05$) which did not differ. These comparisons indicated that the Control Groups SS, SD, DS and DD did not differ in their judgment accuracy. Further analyses which were conducted on the confidence ratings which accompanied the absolute judgments did not indicate any main effects or interactions which were not reflected by the analysis of the deviation scores.

Discussion

The data obtained from the comparative judgment of frequency indicate that RI and PI effects occur. Despite this definitive finding, the comparative judgment data do not support the contextual association hypothesis advanced to account for the inhibition. However, the results obtained from the analyses of the absolute judgment of frequency not only clearly show that RI and PI effects occur, but also strongly support the predictions derived from the hypothesis regarding the performance of the RI and PI experimental groups. The most disturbing observation with reference to these data was that the contextual manipulations had no effect on control group performance.

Table 1

Means and Standard Deviations of the Absolute Deviation Scores for the Experimental-Control x Presentation Context x Judgment Context Interaction

Presentation and Judgment Context	Experimental Groups		Control Groups	
	$\overline{X}$	S.D.	$\overline{X}$	S.D.
SS	33.83	9.01	23.91	4.61
SD	28.00	6.46	25.41	5.97
DS	28.29	8.17	25.29	6.68
DD	31.67	7.21	26.67	5.56

Taken collectively these data are encouraging with respect to the demonstration of RI and PI effects, but are somewhat disappointing in not clearly supporting the predictions made on the basis of contextual associations. However, there are trends in the data which suggest that possibly stronger contextual effects would be obtained if greater situational frequencies were employed. It seems reasonable to assume that if the situational frequencies of the words were substantially increased, that the assumed association between the frequency information and the experimental context would have a greater likelihood of being at or near asymptotic strength. Unfortunately the situational frequencies of words employed in the present experiments may not have been great enough to allow the hypothesized associations to occur at full strength. On the other hand, it is conceivable that idiosyncratic word associations were formed to aid in the memorization of the words and that these associations and not contextual associations were solely responsible for producing the inhibitory effects which were observed. While this is a possibility, it is not considered to be probable in view of the contextual effects which were obtained. Perhaps a more reasonable hypothesis would hold that word associations and contextual associations operate jointly to produce the inhibition.

Despite some shortcomings, the data represented here would appear to have important implications for VD transfer situations and especially for the theoretically elusive W_1-R_2 and reversal paradigms. For instance it is safe to say on the basis of these data that frequency information gained in one task is not perfectly transferred to a subsequent task. If the basis for VD acquisition and transfer is indeed the perception of differential frequency, then one can conclude that the frequency cues are not perfectly transferred to a VD transfer list. Assuming some loss of frequency information (for whatever reason), the decrement in performance predicted by frequency theory for the W_1-R_2 and reversal paradigms on later learning trials would not be expected. If contextual associations are importantly involved in the imperfect transfer of frequency information, then the decrement predicted by frequency theory for the mentioned transfer paradigms would be more likely observed if the two lists were learned in different contexts.

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APPENDIX A

PROSPECTUS

PROSPECTUS

Discrimination between alternatives has long been considered a fundamental psychological process. One need only think of the venerable just-noticeable-difference of classical psychophysics, discrimination learning by rats in T-mazes and mathematical theories of decision and choice to envision the vast scope of interest in this basic process. One approach to the study of discrimination which has been of interest for the past thirty years and particularly for the past six years is verbal discrimination (VD) learning. Because of the large number of articles published since 1966 concerning VD processes, it was felt that a review of the literature was needed before the amount of data became to overwhelming to integrate. The present paper is devoted to such a review and will be limited to the review of theory and data relating only to VD acquisition, transfer and retention. Excluded from this review are studies employing VD as the method for demonstrating phenomena not directly related to acquisition, transfer and retention processes per se (e.g. developmental and population research). These studies were excluded because of considerations of length and because such studies often lie beyond the boundaries of existing VD theory. Following a brief summary of the VD task, the discussion will continue under the general headings: Theory, Acquisition, Transfer, Retention and Conclusions.

The VD task usually takes the form of a simultaneous discrimination in which pairs of verbal units are presented for discrimination. The verbal units are designated by the experimenter as being either correct or incorrect and the subject is required to learn which units in the list are the correct ones. Usually the subject is required to pronounce the unit believed to be correct or to indicate its spatial position, whereupon feedback concerning the correctness of the choice is given.

Theory

The single most important factor responsible for the recent interest in the investigation of VD processes is the frequency theory of VD learning (Ekstrand, Wallace & Underwood, 1966). This theory assumes that the cue for discrimination is provided by the perceived difference in the frequency of occurrence between the right (R) and wrong (W) members of a VD list. Four responses are assumed by Ekstrand et al. (1966) to be the sources of frequency unit addition and which serve to endow the theory with mechanism. First, the representational response (RR) is assumed to add frequency as a function of the subject's perception of the verbal units to be discriminated (Bousfield, Whitmarsh & Danick, 1958). Thus in a two-alternative discrimination, the RR would add a unit of frequency to each of the members yielding a 1:1 ratio of frequency between the R and W item of a pair. Secondly, it is assumed that the pronunciation response (PR) adds another unit of frequency to the item in the pair which is pronounced by the subject. Assuming that the PR is given to the R member of the pair, there will be a 2:1 frequency ratio favoring the R item. The third response hypothesized to add frequency is the rehearsal-of-the-correct response (RCR). The RCR is assumed to add a frequency unit to the R alternative via the overt or covert pronunciation of the the R alternative during the feedback interval. Since the addition of frequency by the RCR is always to the R member of the pair, a frequency difference of 3:1 favoring the R member should theoretically result. The fourth way in which frequency is assumed to be added is through the implicit associative response (IAR; Bousfield, Whitmarch & Danick, 1958). When word-associates are present in a list, the perception of one member of the word-associate pair is assumed to elicit its associate. Thus the presentation of the word King in a list would presumably add frequency to its primary associate, Queen, via the IAR.

It is also noteworthy that Ekstrand et al (1966) have provided for two ways of responding to frequency differences. Rule 1 responding is said to occur when the subject chooses the most frequent alternative and Rule 2 responding occurs when the subject chooses the less frequent alternative. In single list VD learning, the RCR would seem to make Rule 1 responding appropriate while in some VD transfer paradigms Rule 2 responding is appropriate.

Since most of the research in VD learning has been directed at testing deductions from the frequency theory, the discussion of the data which follows will necessarily include theoretical integration and evaluation. Moreover, extensions of the frequency theory and other hypotheses will be discussed when appropriate. Hopefully this approach to the review will serve to indicate needs for further research and perhaps delineate boundaries for the frequency theory.

ACQUISITION

Frequency

Basic to the frequency theory is the assumption that subjects can and do accurately discriminate differences in frequency. The theory explicitly states that if two members of a VD pair are of equal frequency, then adding a hypothetical frequency unit to either member should make the pair more discriminable. Moreover, based on an analogy to Weber's law of psychophysics, the theory states that adding a unit of frequency to an item already high in frequency should be more difficult to perceive than adding a frequency unit to an item low in frequency. The experiments which have required the comparative and/or absolute judgments of experimentally-induced frequency have yielded data which are consistent with the assumption that subjects can discriminate differences in frequency and tend to support the Weber law analogy (Hintzman, 1969; Radtke, Jacoby & Goedel, 1971; Underwood & Freund, 1970 a). Subsidiary to these basic assumptions is the implication that the discrimination of frequency may not depend upon the way in which frequency is manipulated. Thus one could test these basic assumptions when frequency is manipulated: 1) by permitting subjects familiarization with either R or W items or both prior to acquisition of a VD list; 2) by manipulating the number of times a particular R or W item appears in a list; 3) by selecting words of different frequency from normative sources or 4) by varying the percentage of occurrence of the correct response member in feedback.

Familiarization. Of the experiments utilizing a familiarization procedure to induce frequency differences, most have found that the pre-exposure of R items facilitates subsequent VD acquisition whether performance is compared to the performance of a group not given familiarization (Underwood & Freund, 1968a), performance of a group given irrevelant familiarization (Lovelace, 1969; Wallace & Nappe, 1970), or performance of a group given equal familiarization with R and W items (Lovelace, 1969; Smith & Jensen, 1971). Furthermore Runquist and Freeman (1960, Exp. III) using a within-subject procedure, also found the discrimination of pairs to be better when the familiarized member subsequently became an R-item than when the non-familiarized member became an R-item.

The data regarding the familiarization of items which eventually become W-items in a VD list are more difficult to interpret. In experiments utilizing the equal familiarization of R and W items as a control group, there are conflicting results. Lovelace (1969) found W-item familiarization to result in no better performance than equal familiarization of R and W items. However, Smith and Jensen (1971) found acquisition to be facilitated for W-item familiarization relative to a corresponding control condition. A similar disparity exists in experiments employing an irrelevant familiarization control procedure. Wallace and Nappe (1970) found inferior performance for a group given W-item familiarization, but Lovelace (1969) reported a general tendency toward better performance with W-item familiarization (particularly in the early trials). These discrepancies could be due to any number of potentially important factors such as the type of familiarization procedure used, the degree of familiarization allowed, the method of presenting the VD task, the nature of the irrelevant familiarization and many more. Underwood and Freund (1968a) investigated VD acquisition as a function of the number of free-learning trials given to R and W items and obtained an interaction of degree of familiarization and subsequent item function that indicated a greater degree of W-item familiarization is needed to facilitate acquisition compared to R-item familiarization. The theoretical implication of this interaction will be discussed further in the following section.

The studies employing familiarization procedures to test the Weber law corollary have not yielded entirely consistent data. Nevertheless, there is an intriguing pattern to the seemingly discrepant findings. In support of the corollary, some investigators have found low-frequency pairs to be more easily discriminated than high-frequency pairs (Berkowitz, 1968; Skeen, 1970; Wallace & Nappe, 1970). In all of these experiments, relatively common English words were employed while in those studies not supporting the Weber corollary either very low-meaningful items (Runquist & Freeman, 1960) or extremely low-frequency polysyllabic words (Lovelace, 1969) were employed.

Within-list manipulation of frequency. Experiments where the frequency of items within a single VD list was manipulated by varying the number of R and/or W item occurrences generally tend to support derivations from the frequency theory. Ekstrand et al. (1966) demonstrated facilitation of acquisition when the same R-item was paired with two different W-items. Furthermore, when W-items are not repeated, the rate of acquisition is a direct function of the number of R-item repetitions (Paul, 1971; Paul, 1972; Underwood & Freund, 1969).

The data concerning the repetition of W-items when R-items are not repeated, indicate that a single W-item repetition retards acquisition (Ekstrand et al., 1966; Yelen, 1969). Increasing W-item repetition beyond a single repetition produces further retardation of acquisition, but then facilitates learning with higher degrees of W-item repetition (Underwood & Freund, 1969). This latter finding as well as the finding of an interaction of the number of familiarization trials and subsequent VD item function noted in the previous section (Underwood & Freund, 1968a) are perfectly consistent with a Rule 2 mode of responding to frequency differences. Since theoretically there is always a greater accumulation of frequency to the R-item of a pair because of the RCR, relatively greater W-item repetition is required in order to make responding to the less frequent member an effective rule.

One of the more demanding tests of the frequency theory is provided by the designation of words to both R and W functions within a single list, (Ekstrand _et al._, 1966; Kausler & Boka, 1968). According to a strict interpretation of the frequency theory such a list should be impossible to learn. Nevertheless, the acquisition of these double-function lists is achieved although the rate of acquisition is severely impaired when contrasted to the acquisition of a partial double-function list (Kausler & Boka, 1968) and a single-function list (Ekstrand _et al._, 1966; Kausler & Boka, 1968). On the basis of these data, it would appear that processes other than the perception of differential frequency are involved in the acquisition of double-function VD lists. In accord with Kausler's (1966) multiple-component analysis, Kausler and Boka (1968) suggest that VD learning involves both intentional (recognition of R and W items) and incidental (acquisition of W-R associations and acquisition of W and R items _qua_ responses) components. They assume the greater difficulty experienced in the acquisition of double-function lists is due to the entrance of a single word into two different incidentally acquired intrapair associations. They argue that these intrapair associations must be intentionally discriminated before mastery of the double-function list is achieved. This multiple-component hypothesis of VD learning will be discussed at greater length in the remaining sections concerned with VD transfer and retention.

Normative manipulation of frequency. Most of the studies manipulating the normative frequency of words have been between-pair variations, and hence are pertinent to the discussion of the Weber law corollary. Several studies have indicated no differences in the acquisition of low and high frequency word pairs (Ingison & Ekstrand, 1970; Paivio & Rowe, 1970; Rowe & Paivio, 1971, Exps. II and III) while other have obtained either partial support for the Weber corollary (Postman, Exp. III, 1962) or highly restricted support for it (Rowe & Paivio, Exps. I & IV, 1971). No doubt some of the disparity in these data is due to the lack of precision in the physical scaling of frequency and possibly to idiosyncratic differences in the perception of frequency for certain words. Rowe and Paivio (1971) found no effect for frequency when a relatively small range of frequency differences were sampled and the effects which were obtained were generally restricted to low-imagery word pairs. Hence the reported absence of a word-frequency effect could also be due to the sampling of a relatively small range of frequency differences by those investigators. If one assumes that the processes involved in the discrimination of experimentally produced and normative differences in frequency are either identical or are analogous, then the interaction of normative frequency with the imagery attribute obtained by Rowe and Paivio (1971) would seem paradoxical insofar as the frequency effects demonstrated using familiarization techniques were restricted to a relatively higher word-frequency range and presumably to pairs possessing greater image-evoking capacity (Berkowitz, 1968; Skeen, 1970; Wallace & Nappe, 1970).

Percent occurrence of correct response member. The only published data available in which frequency is manipulated by varying the percentage of occurrence of the R-item in feedback generally indicate an inverse relationship between this variable and the number of trials needed to reach learning criterion (Gamboni, Gaustad & Wilson, 1972; Newby & Young, 1972). Since the reduced percentage of occurrence of the R-item theoretically reduces the addition of frequency to the R-items from the RCR and hence reduces the frequency differential between W and R items, this relationship would be predicted by the frequency theory.

Meaningfulness

The studies which have been conducted with the intent of determining the effects of meaningfulness upon the rate of VD acquisition have involved both within-pair and between-pair variations. The data relating the within-pair manipulation of meaningfulness to VD acquisition have uniformly indicated better performance when the members of the to-be-discriminated pair differ in meaningfulness than when they are equivalent (Runquist & Freeman, 1960; Schulz & Hopkins, Exp. III, 1968; Ullrich & Balogh 1972). To the extent that meaningfulness and frequency are correlated, these data are in accord with the frequency theory.

The data concerning the between-pair manipulation of meaningfulness are in conflict. Some investigators have reported faster acquisition for high-meaningful pairs than for low-meaningful pairs (Runquist & Freeman, 1960; Schulz & Hopkins, Exp. III, 1968; Ullrich, 1972). However, the differences obtained by Runquist and Freeman (1960) were marginal, meaningfulness interacted with the sensory mode of presentation in the Schulz and Hopkins (1968) experiment, and meaningfulness interacted with the number of alternatives in the Ullrich (1972) experiment. Other investigators (Keppel, 1966; Paivio & Rowe, 1970) have obtained no differences in acquisition as a function of the between-pair manipulation of meaningfulness.

Paivio and Rowe (1970), who obtained no effect for meaningfulness when the imagery and frequency attributes of words were held constant, suggest that the between-pair effects which have been reported were possibly due to concomitant variations in imagery or to the particular materials and/or presentation procedures used. It is also conceivable that the differences which were obtained were the result of uncontrolled variations in item frequency. From the standpoint of the frequency theory, variations in meaningfulness _per se_ should not differentially affect VD performance when integrated units are involved, since only the attribute of frequency is assumed to be the basis for discrimination. On the other hand, the theory does predict a decrement in performance when non-integrated units are involved in the discrimination. This decrement would be expected on the basis of RR's, PR's and RCR's being letter responses instead of responses to integrated units. The repetition of letters in such a list would theoretically result in the confusion of RR's, PR's, and RCR's, and hence produce a performance decrement. Since two of the studies reporting differences in performance as a function of between-pair variation of meaningfulness utilized non-integrated units as comparison materials (Runquist & Freeman, 1960; Ullrich, 1972), most of the data reviewed here could be considered consistent with predictions from the frequency theory.

Word Association

All of the experiments utilizing word-associates appear to have been prompted by deductions from the frequency theory concerning the IAR. The theory predicts interference relative to the acquisition of a control list of unrelated items when: 1) word-associates constitute a to-be-discriminated pair (an intrapair manipulation of the IAR); 2) word-associates are R and W members of different pairs (an interpair manipulation of the IAR); and 3) word-associate pairs are all designated as W members of a list. The theory predicts facilitation of acquisition when the word-associate pairs are R members of a list (interitem manipulations of the IAR).

Intrapair and Interpair association. The data relating the intrapair manipulation of word-associates to VD acquisition are in conflict and are generally inconsistent with expectations from frequency theory. Only one investigation has shown impeded acquisition as a function of the intrapair association of verbal items (Palermo & Ullrich, 1968) while others have shown either a facilitating effect (Barch, Lippman & Whalen, 1967) or no effect (Eberlein & Raskin, 1968; Fulerson & Kausler, 1969; Lovelace & Schulz, 1971; Zimmerman, Shaughnessy & Underwood, 1972). Barch *et al*. (1967) have proposed a two-stage memory hypothesis which assumes that subject tags one item of a pair as correct and collapses the tag over the pair for ease of storage and subsequent retrieval. The tagging and collapsing is assumed to be facilitated when a high degree of association exists between the members of a to-be-discriminated pair. While Barch *et al*. (1967) do not predict facilitation of acquisition as a function of intrapair association in all cases, they do suggest that there should be no decrement in performance as a result of a strong intrapair association. Therefore, most of the studies utilizing strong associates between W and R items tend to support the two-stage memory conception (Barch, Lippman & Whalen, 1967; Barch & Whalen, 1970a; Barch & Whalen, 1970b; Eberlein & Raskin, 1968; Fulkerson & Kausler, 1969; Lovelace & Schulz, 1971; Zimmerman, Shaughnessy & Underwood, 1972). It should be noted that while Palermo and Ullrich (1968) found acquisition to be impeded as a consequence of intrapair association, their rate of presentation in three of the experiments was a relatively rapid 1 sec rate which perhaps did not permit time for the compensatory "tagging" process to be employed. In a fourth experiment, the rate was 2 sec, but the subjects were fourth grade children rather than college students and the same comment may therefore apply. The two-stage memory hypothesis also implies that lists having intrapair association should be less difficult to learn than lists having high interpair associations while frequency theory suggests that there should be no difference in performance as a consequence of these different word-associate manipulations. However, the acquisition (Eberlein & Raskin, 1968; Fulkerson & Kausler, 1969) and recall data (Fulkerson & Kausler, 1969) available comparing these types of associative variations within a single experiment tend to support the former hypothesis. In contrast to these data, the data relating the interpair manipulation of word-associates to acquisition are consistent with predictions from frequency theory. The investigators who have studied interpair associative relationships have generally found acquisition to be adversely affected (Ekstrand _et al._, 1966; Eberlein & Raskin, 1968; Fulkerson & Kausler, 1969). In exception to these data, Zimmerman _et al._ (1972) did not observe differential performance as a function of interpair associations, but nonetheless observed a tendency toward poorer performance when interpair associations existed.

Interitem association. Unfortunately, not all of the data regarding the interitem manipulation of word-associates are in complete accord with the frequency theory account. Some investigators have found that designating word-associate pairs as R members aids acquisition relative to the acquisition of an unrelated control list (Ekstrand _et al._, 1966; Kanak, Cole & Eckert, Exp. IV, 1972). Others have not observed this facilitation (Kanak, Cole & Thornton, 1970; Kanak, et al., Exps. I, II, & III, 1972). Indeed, Kanak et al. (1970) found this type of condition to impede performance. Nevertheless, most investigators have found that the designation of word-associate pairs as R-items enhances acquisition relative to the designation of word-associate pairs as W-items (Ekstrand et al., 1966; Kanak et al., Exps. I, II, III & IV, 1972) and this finding could possibly be construed as supporting the frequency theory. Likewise most investigators have failed to observe the predicted decrement in performance when word-associate pairs are designated as W-items (Ekstrand et al., 1966; Kanak et al., Exps. I, III, & IV, 1972). Only two experiments have found the predicted decrement (Kanak et al., 1970; Kanak et al., Exp. II, 1972).

On the basis of these data, it would appear that the interitem manipulation of word-associate pairs does not reliably affect acquisition in the manner suggested by the theory. However, in view of the normative nature of word associations and the possibility that idiosyncratic associations override normative associations, one might not expect the effects to be powerful. On the other hand, it is conceivable that the designation of word-associate pairs as all R or as all W members of a list produce an incidental cue which serves as the basis for the use of a conceptual strategy. This notion would imply that instructions concerning the composition of lists possessing interitem associations might facilitate learning whether the word-associate pairs were designated as R-items or as W-items. Such instructions in a single-list experiment (Kanak et al., Exp. IV, 1972) and transfer experiments (Cole & Kanak, 1972; Raskin, Boice, Rubel & Clark, 1968) have yielded effects which are consistent with this hypothesis.

Similarity

The actual effects of variations in similarity on acquisition are often difficult to interpret because of the numerous ways in which this general attribute can be employed and because the specific manipulations are often dependent (e.g. lion and line are acoustically similar words, but also possess a high degree of formal similarity). Nevertheless, some attempts have been made to separate the effects of different types of similarity on VD performance in a variety of intralist manipulations. To date, formal, acoustical, meaningful and conceptual similarity have been studied.

Formal and acoustical similarity. One problem peculiar to the manipulation of formal similarity is holding within-pair similarity constant while attempting to vary between-pair similarity and vice versa. Because of the limited number of letters in the alphabet, there is always the possibility that unwanted intralist similarity is introduced into lists and this becomes more probable as the length of the list or the number of choices within a discrimination increases.

Underwood and Archer, (1955) found lists possessing a low degree of formal similarity both within and between-pairs were learned more quickly than corresponding lists possessing high formal similarity. Edwards (Exp. I, 1966) using a four-choice discrimination attempted to assess the relative effects of high-within and between-choice formal similarity and found only the between-choice treatment to impede acquisition. Edward's (1966) interpretation of the failure to obtain an interfering effect of high within-choice similarity was that his method of presentation conceivably permitted the formation of a functional cue of "difference" (in visual representation) among the items in a choice, thus mitigating the detrimental effects of within-choice similarity. Yelen (1969) attempted to hold between-choice formal similarity constant at a low level while varying within-choice similarity and found acquisition to be impaired as a function of high within-choice similarity. In contrast to Yelen's (1969) finding, Radtke (1968) obtained no effect for within-choice formal similarity. Nevertheless, the null result is possibly due to the confounding of within-choice and between-choice similarity despite efforts to hold between-choice similarity constant. The list possessing low within-choice similarity could also possess high between-choice similarity and vice versa. As Radtke (1968) indicates, if between-choice similarity produces equal or greater amounts of interference than within-choice similarity, then the within-choice effects would be cancelled. Taken collectively, the data yielded in the other experiments (Edwards, 1966; Yelen, 1969) would tend to support Radtke's interpretation. According to the frequency theory, there should be some decrement in performance as a function of both of these types of manipulations because of the assumed confusion of RR's made to visually similiar members and particularly if these members hold opposing item functions within a list.

In a manner identical to the interpair manipulation of word-associates, Schulz and Lovelace (1972) found high formal similarity to interfere with VD acquisition. Likewise the investigators who have been concerned with this same intralist manipulation have obtained comparable effects for acoustical similarity and/or identity of words (Kausler & Olson, 1969; Schulz & Lovelace, 1972). In addition, Schulz and Lovelace (1972) found that the purposeful confounding of acoustical and formal similarity in an interpair condition interfered more with acquisition than when either type of similarity was varied alone.

The data concerning the effects of intrapair acoustical similarity and/or identity on VD acquisition are in conflict. While no effect has been observed in both within-subject (Barch et al., 1967) and between-group experiments (Barch & Whalen, 1970a), one between-group experiment has yielded data indicating a detrimental effect (Kausler & Olson, 1969). Since it is conceivable that the mixed-list procedure interferes with the operation of potentially important processes required for the acquisition of acoustically similar pairs (Kausler, 1972) a brief analysis of the conflicting data yielded by the between-group experiments is appropriate. Upon examination of these experiments two points can be emphasized which make interpretation of the conflicting data easier. First, when the acquisition of a list containing acoustically similar pairs is compared to the acquisition of a list containing associatively related pairs, there is a decrement attributable to the acoustical factor (Barch & Whalen, 1970a). Secondly, when the acquisition of a list having intrapair acoustical similarity is compared to the acquisition of a list having interpair acoustical similarity, poorer performance is exhibited in the learning of the interpair list (Kausler & Olson, 1969). In view of the previously discussed two-stage memory hypothesis advanced by Barch et al. (1967) the first observation would appear to indicate that the existence of association hypothesized to facilitate the tagging and collapsing of associatively related pairs is absent in acoustically similar pairs. However, it is possible that the difference in visual representation of similar or identical sounding pairs could serve to aid the tagging and collapsing of the pairs for ease of storage and retrieval. This would seem particularly reasonable in view of the second point noted above. The second observation would suggest the presence of a facilitating component (or the absence of an interfering component) in the intrapair condition relative to the interpair condition which is compatible with the Barch _et al_. hypothesis. The frequency theory would predict a decrement in performance as a function of intrapair acoustical similarity (acoustical component of RR and RCR is the same for both R and W items in the pair), but it apparently is not capable of accounting for differential rates of acquisition as a function of these two different types of intralist manipulations of the acoustical variable.

The recent standardization of homonyms with respect to their orthographic distinctiveness (Olson & Kausler, 1971) has permitted the systematic variation of formal similarity while keeping the acoustical attribute constant and vice versa. Kausler (1972) has proposed a feature-tagging hypothesis which assumes that the difficulty of intrapair discriminations increases as the degree of visual and acoustical feature-sharing between items increases. In an experiment comparing the acquisition of three lists differing in the degree of formal similarity between homonyms constituting the pairs to be discriminated, Kausler (1972) obtained the predicted inverse relationship between rate of acquisition and the degree of similarity holding between the homonyms.

Meaningful and conceptual similarity. Those who have studied meaningful and conceptual similarity have found an interfering effect on acquisition attributable to high intrapair relationships (Ahammer & Goulet, 1969; Radtke & Foxman, 1969; Underwood & Viterna, 1951). Furthermore, high between-pair synonymity has been found to impede the rate of acquisition (Radtke & Foxman, 1969). The data pertaining to the detrimental effects of intrapair meaningful and conceptual similarity are inconsistent with the two-stage memory hypothesis (Barch _et al_., 1967) and entirely consistent with deductions from the frequency theory. Nevertheless, Ahammer and Goulet (1969) used conceptually similar pictures which possibly possess features which diminished intrapair relatedness and made tagging of the pair cumbersome. Despite this possibility, the remaining data are still inconsistent with the tagging notion. This is paradoxical since presumably the association said to facilitate tagging and collapsing is present to some degree when meaningful or conceptual similarity exists within the pair.

Kausler, Erber and Olson (1970) found acquisition to be significantly accelerated when R-items belonged to the same taxonomic category and slightly accelerated when W-items belonged to a single taxonomic category. This result would suggest that a single concept (e.g. animal names) comes to mediate discrimination of all the pairs in the list and that the mediation is aided more when the concept applies to the R-items than to the W-items.

Imagery

Recently investigators have studied the relationship between the image-evoking attribute of words while keeping the frequency and meaningfulness value of words constant. This research was given impetus by the establishment of norms for concreteness, imagery and meaningfulness of 925 nouns (Paivio, Yuille & Madigan, 1968). Of the studies which have varied the imagery attribute between the pairs to be discriminated, most have found faster acquisition of high-image pairs than for low-image pairs (Paivio & Rowe, 1970; Rowe & Paivio 1971a; Rowe & Paivio, 1972; Ullrich & Balogh, 1972). The sole exception to this finding was reported by Ingison and Ekstrand (1970) who failed to find an effect for concreteness on acquisition, but the concrete and abstract words used were possibly not clearly differentiated on the imagery attribute (Rowe & Paivio, 1971a; p. 325). The between-pair effect of the imagery attribute has also been shown to be robust across several methodological variables. High-imagery pairs are learned faster than low-imagery pairs whether mixed or unmixed lists are used (Rowe & Paivio, 1971a), whether constant or vaired position of items within each paired is maintained, whether both items or only the R-item is pronounced in feedback and whether the anticipation or study-test method of presentation is used (Rowe & Paivio, 1972). The only data available contrasting the within-pair variation of imagery indicate that the discrimination of pairs differing in rated imagery is easier than the discrimination of pairs possessing approximately the same rated imagery (Ullrich & Balogh, 1972). Studies have also indicated that instructions to form images to R-items facilitates acquisition relative to instructions to repeatedly pronounce the R-items and non-instruction (Rowe, 1972a; Rowe, 1972b; Rowe & Paivio, 1971b). Likewise Rowe and Paivio (1971c) found the discrimination of pictures to be easier than the discrimination of either concrete or abstract word-pairs.

All of the studies reviewed here provide solid evidence for the fact that imagery, whether manipulated via rated imagery, use of picture materials, or instructions to use images, is a potent variable affecting VD acquisition. This is quite significant from a theoretical standpoint since there is no explicit or implicit provision in the frequency theory to account for such effects. Since images apparently mediate discrimination in many VD problems, other theoretical accounts are needed.

Verbalization

Very basic to frequency theory is the assumption that the pronunciation of an item results in the addition of a frequency unit to it. In a direct test of this assumption, Hopkins, Boyce and Lincoln (1972) found pronunciation to increase the apparent frequency of words whether comparative or absolute judgments of frequency were required. Other investigators who have tested deductions from frequency theory concerning the effects of verbalization on acquisition have used widely differing procedures, subjects and materials. Nevertheless, rather definitive effects for pronunciation have been isolated. For example, when the pronunciation of both W and R members is compared to no pronunciation in feedback, acquisition has consistently been found to be impeded as a function of the pronunciation (Carmean & Weir, 1967; Goulet & Hoyer, 1969; Hopkins & Epling, 1971; Kausler & Sardello, 1967; Rowe & Paivio, 1972; Sardello & Kausler, 1967; Underwood & Freund, Exp. II, 1968a). Using a slightly different procedure Weir and Helgoe (1968) also found acquisition to be retarded relative to a non-pronouncing group when pronunciation of W and R members occurred randomly an equal number of times per item. The sole exception to this general finding was obtained by Goulet (1969) using nursery school children as subjects, drawings as stimuli, unpaced presentation and pronunciation of both W and R stimuli during the anticipation interval instead of the feedback period. Under the enumerated conditions, there was an observed tendency toward faster acquisition for the group required to pronounce both items.

The pronunciation of only the R-item in feedback enhances acquisition when contrasted to no pronunciation (Carmean & Weir, 1967; Underwood & Freund, Exp. II, 1968a; Weir & Helgoe, 1968) and when contrasted to W and R item pronunciation in feedback (Carmean & Weir, 1967; Underwood & Freund, Exp. II, 1968a). In addition, Carmean and Weir (1967) using drawings of animals as stimuli found no effect for the pronunciation of only the W-item in feedback. While this latter finding is not in accord with the expectations of frequency theory, the use of drawings instead of verbal materials could possibly mitigate any detrimental effect of W-item pronunciation.

For the most part, the data regarding the effects of verbalization on acquisition are generally consistent with derivations from the frequency theory. However, the detrimental effects attributed to the pronunciation of both W and R members in feedback could possibly be due to the effectively reduced time for rehearsal of the R-item rather than to pronunciation per se. In a test of this hypothesis, Hopkins and Epling (1971) found no pronunciation to produce faster acquisition than verbalization of both W and R items whether the study interval was 1, 2 or 4 sec in duration.

Another theoretical question concerning verbalization in VD acquisition is the assumption that overt (PR) and covert (RCR) pronunciation result in the equal addition of frequency. In an experiment in which overt or assumed covert pronunciation was permitted in either anticipation or in feedback, Cole and Kanak (1971) obtained data indicating that overt and covert pronunciation exert nondifferential influence on acquisition.

Number of Alternatives

Although there have been relatively few experiments comparing acquisition as a function of the number of verbal units within a discrimination (e.g., 2 vs. 4), those reported have indicated either no differences in the rate of acquisition (Radtke, 1968; Ullrich, 1972) or faster acquisition for groups having the greater number of alternatives within the choice (Radtke & Foxman, 1969; Radtke, McHewitt & Jacoby, 1970).

These differences were obtained whether the data were corrected with respect to the differential probabilities of guessing the correct alternative in the two conditions (Radtke & Foxman, 1969) or not (Radtke, McHewitt & Jacoby, 1970). Recognition and recall measures taken also indicate poorer retention of W alternatives for groups receiving more W alternatives in acquisition (Radtke, 1968; Radtke & Foxman, 1969). Radtke et al. (1970) have argued that with constant presentation rates, the subject in a two-alternative task should suffer more from increased RR's to W-items relative to the subject in a four-alternative discrimination. This argument implies that one should obtain an interaction of number of alternatives with the size of the anticipation interval. Nevertheless, Radtke et al. (1970) found faster acquisition for four-alternative lists than for two-alternative lists, but obtained no interaction of number of alternatives with the size of the anticipation interval. The failure to obtain this interaction was possibly due to the nature of the processes hypothesized to occur in the anticipation interval and will be discussed more appropriately in the section concerning temporal variables. It should be noted that Ullrich (1972) obtained an interaction of meaningfulness and number of alternatives which indicated nondifferential acquisition when high frequency words served as alternatives and poorer acquisition in four-alternative condition when trigrams served as alternatives.

Methodological Variables

First trial guessing. According to the frequency theory, the elimination of an initial guessing trial should facilitate VD learning due to the theoretically concomitant elimination of PR's to W-items. Dominowski (1966) in an analysis of other investigators' data (Spear, Ekstrand &

Underwood, 1964; Underwood, Jesse & Ekstrand, 1964) found that guessing correctly on the initial trial tended to enhance performance on the subsequent two trials relative to guessing incorrectly on the initial trial. Kanak et al. (1972, Exp. I) observed a decrement in performance due to first trial guessing as did Fulkerson & Johnson (1971), but unlike the latter investigators, Kanak et al. (1972, Exp. I) did not obtain an interaction of initial guessing and method of presentation. On the other hand, Wike (1970) failed to find an effect due to the guessing variable. In general, the data indicate that guessing does not exert a powerful influence on acquisition, but when differences attributable to guessing are obtained they are usually in the direction predicted by the frequency theory.

Method of presentation. Those who have compared acquisition under anticipation and study-test methods of presentation have typically found faster learning in the study-test method (Battig & Switalski, 1966; Fulkerson & Johnson, 1971; Ingison & Ekstrand, 1970; Kanak et al., 1972). Battig and Switalski (1966) have explained the superiority of the study-test method in terms of its permitting the separation of storage and retrieval processes while the anticipation method is said to require the rapid alternation between storage and retrieval processes. Underwood, Shaughnessy and Zimmerman (1972a) obtained data indicating superiority of the study-test procedure on an initial learning trial despite the fact that the initial study trial was identical in both their anticipation and study-test procedures. This would indicate that the ability to perform what has been learned is interfered with by new learning in the anticipation method and would tend to support the separation of function hypothesis advanced by Battig and Switalski (1966). However, Underwood _et al._ (1972a) observed study-test superiority only when relatively long lists were learned (45 pairs) and observed no differences in performance when shorter lists were learned (15 pairs). This finding is inconsistent with the data noted previously (Battig & Switalski, 1966; Fulkerson & Johnson, 1971; Ingison & Ekstrand, 1970; Kanak _et al._, 1972), since the list lengths employed by these investigators generally conformed to the short list condition of Underwood _et al._ (1972a). An hypothesis advanced by Underwood _et al._ (1972a) to account for this disparity holds that the differences between methods of presentation is directly related to the number of unlearned discriminations existing after the initial learning trial. Hence, the performance differences observed as a function of the presentation method with relatively short lists would be attributed, for whatever reason, to a low degree of learning on the initial trial. This hypothesis is presently without empirical support.

Feedback conditions. The way in which feedback is conducted in the VD task is of theoretical interest. According to the frequency theory, the presentation of both W and R items (without the requirement of pronunciation) in feedback should impede acquisition when contrasted to the presentation of only the R-item. Theoretically, the presence of the W-item in feedback should result in the addition of frequency to it via the RR, thus decreasing the frequency differential between the items to be discriminated. Furthermore, presenting only the W-items in feedback should retard acquisition relative to presenting only the R-item in feedback for the same reasons noted above. The data bearing on these questions are clearly supportive of the theoretical predictions

(Ingison & Ekstrand, 1970; Newby & Young, 1972b; Wike, 1970).

Another question, not related to frequency theory, but which has nevertheless generated research concerns the relative benefits of verbal reinforcement combinations on VD acquisition. In general it has been found that saying "right" after a correct response and nothing after an incorrect response is inferior to other verbal reinforcement combinations (saying "wrong" after an incorrect response and nothing after a correct response; and saying "right" after a correct response and "wrong" after an incorrect response). However, the inferiority of this verbal reinforcement combination, has been shown to be due to subject's uncertainty concerning the meaning of nothing after an incorrect response (Kausler & Lair, 1968; Lovelace, 1966; Spence, 1964; Spence, 1966a; Spence, 1966b; Spence & Dunton, 1967; Spence, Lair & Goldstein, 1963; Spence & Lair, 1965; Spence & Segner, 1967).

Serial vs. random order. The limited data available concerning the presentation sequence of pairs indicate non-differential acquisition as a function of serial vs. random presentation order of pairs. Furthermore this variable does not interact with the conduct of an initial guessing trial, the method of presentation, or the sex of the subject (Fulkerson & Johnson, 1971).

List length. The frequency theory states that increasing the number of pairs in a VD list should have no effect upon the rate of acquisition. However, this counterintuitive prediction is restricted to list length *per se* and not to variables which often accompany lengthtened lists (e.g. increased formal similarity and increased interitem associations). The data pertinent to this prediction are somewhat ambiguous. Because of the extreme difficulty of constructing lengthy lists without also introducing undesired variables, the frequency theory would appear to tolerate small differences in acquisition as a function of differential list length. Underwood et al. (1972a) obtained statistically reliable differences in acquisition favoring the shorter lists, but interpreted the magnitude of the difference as one acceptable to frequency theory.

Mode of presentation. Another presentation variable of consequence to acquisition is the sensory mode required by the discrimination task. Although this variable is not explicitly addressed by frequency theory, the theory implies that no differences should occur in acquisition as a function of the sensory system required by the task. It is assumed here that the RR is equivalent whether it be a visual or an aural response. The available data indicate no main effect differences for the sensory mode of presentation (Kanak et al., 1972; Schulz & Hopkins, 1968), but do indicate that the visual presentation of items results in better performance than aural presentation when low-meaningful materials are used (Schulz & Hopkins, 1968).

Temporal Variables

Presentation rate. The investigators who have studied the effects of the total presentation interval (without regard to the independent manipulation of the anticipation and feedback intervals) on acquisition have uniformly found learning to be enhanced as a function of slower presentation rates (Kanak, 1968; Kanak et al., 1972; Underwood & Archer, 1955; Underwood & Viterna, 1951). However, such studies do not directly address the separate predictions of frequency theory regarding interference and facilitation for increased anticipation and feedback times, respectively.

A number of investigators have addressed the separate predictions more directly by varying the time of the anticipation interval while holding the feedback interval constant and vice versa.

Anticipation time varied. According to the frequency theory, increases in the anticipation interval should have no effect on acquisition or even a slight inhibitory effect. The slower acquisition would be expected because of the potential for a greater number of RR's to be elicited to W-units and consequently retard the development of a frequency differential. Nevertheless, contrary to this prediction, increased anticipation time has been found to enhance performance whether it is increased in the second list of a transfer task (Crouse, 1967; Underwood, Jesse & Ekstrand, 1964) or when it is varied within single list experiments (Radtke, et al., 1970; Wike & Wike, 1970). In exception to these data, Wike (1970) observed no differences in acquisition as a function of anticipation interval despite the observation of a trend toward fewer errors with longer anticipation time. Although the data obtained from single list experiments appear to be damaging to the frequency theory, it should be noted that relatively large differences in the anticipation intervals are necessary (at least 4 sec in all cases) to facilitate acquisition. When relatively small differences in anticipation time are used, generally no performance differences are observed (Wike & Wike, 1970; Wike, 1970). Nonetheless the enhancement of performance with relatively large differences in the anticipation time cannot be accounted for by the frequency theory, at least in its present form. However, a potential explanation for the unexpected effects of increased anticipation time has been suggested (Mueller and Flanagan, 1972; Radtke, et al., 1970). These authors have reasoned that rehearsal may not be restricted to the feedback interval and that it possibly occurs during the anticipation interval, particularly after learning has progressed beyond the point of guessing. Although there is presently no substantial support for this hypothesis it would appear to have testable characteristics.

It is especially difficult to interpret the data obtained from the transfer experiments (Crouse, 1967; Underwood et al., 1964) because of the interlist changes in anticipation rate. These interlist changes in the anticipation interval represent the learning of lists in different temporal contexts and the different contexts could be partially or completely responsible for the effects attributed to variations in the anticipation rate. On the other hand, learning to rehearse during the anticipation interval may be a component of learning to learn which transfers to the second list. This latter interpretation would be more compatible with the hypothesis advanced above by Mueller and Flanagan (1972) and Radtke et al. (1970).

Study time varied. Theoretically, an increase in the duration of the study interval should facilitate learning due to the greater time permitted for rehearsal. Although Ekstrand et al. (1966) assumed, primarily for convenience, that only one RCR need occur in feedback to make learning on the basis of perceived frequency differences possible, it is generally expected that more RCR's occur with increased study intervals. The available data are generally supportive of this expectation. Longer feedback intervals have been demonstrated to enhance acquisition when low-meaningful materials are used (Wike & Wike, Exp. II, 1970), when the study-test method of presentation is used exclusively (Hopkins & Epling, 1971), when anticipation and study-test procedures are compared in the same experiment (Ingison & Ekstrand, 1970) and when the percentage of the occurrence of reinforcing information is varied (Gamboni et al., 1972).

On the other hand, Skeen (1970) using a verbal feedback procedure and Wike and Wike (1970) using high-meaningful CVC's found no effect for increased study time. Furthermore the latter investigators in two factorial experiments failed to obtain the interaction of anticipation interval and feedback interval that would be expected by frequency theory. However, the failure by Skeen (1970) to obtain differential performance was in all likelihood due to the type of feedback procedure employed which possibly interfered with the effective rehearsal of R-items. The failure by Wike and Wike (1970, Exp. I) to observe differences is more interesting. Taken collectively, the two experiments conducted by these authors would suggest that increased study time enhances performance when low-meaningful CVC's are represented, but has no effect on performance when high-meaningful CVC's are used to make up the lists. Nevertheless, the relationship between the meaningfulness attribute and presentation rate has not been investigated factorially in VD learning despite its potential theoretical significance.

Total time to learn. The total-time hypothesis (Bugelski, 1962) states that the total amount of time necessary to learn a fixed amount of material remains constant, regardless of the number of trials into which the time is divided. The preponderance of research directed at testing this hypothesis has employed paired-associate, free-recall and serial learning procedures (Cooper & Pantle, 1967). The dependent variables used to test the total-time hypothesis have taken various forms, but generally either total time is held constant and correct responses are analyzed or learning is carried to some criterion and total time to learn is compared (Cooper & Pantle, 1967). Recently the total-time hypothesis has been investigated using the VD task. Kanak (1968) using the anticipation procedure, varied the anticipation and study times simultaneously (1:1, 2:2 and 4:4) and found that the total time required to learn to a prespecified criterion increased with increased durations of exposure. The Kanak study (1968) was an inappropriate test of the total-time hypothesis since the rates were not factorially varied. However, Mueller and Flanagan (1972) also using the anticipation procedure, factorially varied anticipation and study duration during the course of learning and like Kanak (1968) obtained differences in the total time to learn, but obtained support for the hypothesis when the total correct responses were analyzed. As Mueller and Flanagan (1972) indicate, the latter measure would appear to be more suitable for testing the total-time hypothesis since the time-to-learn measure does not permit the specification of equal learning time for all subjects. The inappropriateness of this measure lies in the inability of the experimenter to unequivocally state that subject effectively uses all the time allotted to him for learning.

TRANSFER

Classical Paradigms

The two major influences upon the evolution of research in VD transfer have been the frequency theory and the component-analysis tradition of paired-associate transfer. The frequency theory addresses itself primarily to those VD transfer paradigms in which old W or old R items or their associates occur in the second list and learning in the transfer task .

is assumed to be governed by application of Rule 1 and Rule 2 modes of responding to frequency differences. In addition, Kausler (1966) proposed an extension to the frequency account which relects the influence of the component-analysis tradition of paired-associate transfer. Briefly Kausler's multiple-component analysis of VD transfer assumes that VD learning is composed of intentional and incidental components. The intentional component is said to involve the recognition of W and R elements as items and to be governed in most cases by perceived frequency differences. The incidental component is assumed to involve the formation of intrapair (W-R and R-W) associations which may facilitate or impede transfer performance depending upon the paradigm being investigated. This incidental component is viewed as a Type II incidental learning situation (McLaughlin, 1965) in which intentional and incidental learning occur simultaneously. The notion that intrapair associations are formed during the course of VD acquisition is not without empirical support (Battig, Williams & Williams, 1962; Keppel, 1966; Sardello & Kausler, 1968; Spear, Ekstrand & Underwood, 1964; Zechmeister & Underwood, 1969). Nowhere are these two influences so salient as in the research regarding VD paradigms considered analogous to the classical paired-associate transfer paradigms.

The W_1-R_1, W_1-R_2 paradigm. When performance on a transfer list composed of old W-items and new R-items (W_1-R_1, W_1-R_2) is compared to performance on a transfer list composed of new W and R items (W_1-R_1, W_2-R_2 nonspecific transfer control), a net negative transfer effect is obtained whether mixed list (Kausler & Dean, 1967) or unmixed list procedures are employed (Kanak & Dean, 1969). Kausler, Fulkerson and Eschenbrenner

(1967) failed to obtain a net negative transfer effect, but nevertheless observed a trend toward negative transfer.

Underwood, Jesse and Ekstrand (1964) instructed their subjects concerning the interlist relationships in the W_1-R_2 paradigm and obtained data which indicated initial positive transfer followed by negative transfer on later trials when faster presentation rates were used (1.5:2). With a slower rate of presentation (3:2), Underwood et al. did not observe negative transfer on the later learning trials. The data obtained with the faster presentation rates are entirely consistent with the frequency theory account of transfer in the W_1-R_2 paradigm. The original adoption of a Rule 2 mode of responding would lead to facilitation on early trials while the gradual diminution of the frequency differential during later trials of second list learning would require an eventual shift to Rule 1 responding, resulting in a performance decrement at the point in learning where the initial frequency differential breaks down. Kausler and Dean (1967) and Kanak and Dean (1969) using neutral transfer instructions, found early negative transfer which was sustained throughout second list learning in the W_1-R_2 paradigm. Kausler and Dean (1967) suggested that the instructions giving subjects knowledge of the interlist relationships in the Underwood et al. (1964) experiment served to mask on the early trials the potential deleterious effects of incidentally learned first list intrapair associations. This reasoning would also suggest that the slower rate of presentation in the Underwood et al. (1964) experiment allowed subjects greater time to effectively use the information about the constitution of the second list and hence override the deleterious effects of associative interference. Kausler, Fulkerson and Eschenbrenner

(1967) have reasoned that first list incidentally formed W-R associations enter into competition with corresponding second list W-R associations and must be unlearned in a manner similar to the A-B, A-C paired-associate transfer paradigm. Consistent with this reasoning and the multiple-component conception in general, Kausler et al. (1967) obtained associative recall data indicating significant unlearning of first list associations in the W_1-R_2 paradigm relative to the W_2-R_2 paradigm and a single list normal forgetting control group. Wallace, Remington and Beito (1972) also observed relearning and associative recall decrements when the retention of first list was required, but the associative recall decrement was found to be restricted to a longer retention interval (10 vs. 25 min.). Kanak and Dean (1969) have suggested that since competition effects cannot be verified through a measure such as intrusions or non-response errors due to the recognition nature of the task, competition most likely produces its effect through a longer latency and a reduced confidence level. Systematic tests of these notions have not yet been reported.

The W_1-R_1, W_2-R_1 paradigm. When performance on a transfer list composed of new W-items and old R-items is compared to W_2-R_2 performance, a net positive transfer effect is obtained, again whether mixed lists (Kausler & Dean, 1967) or unmixed lists are employed (Eschenbrenner & Kausler, 1968; Kanak & Dean, 1969; Underwood et al., 1964). According to the frequency theory, the greater build-up of frequency to R-items during first list learning would make Rule 1 responding appropriate in the second list and pronounced positive transfer would be expected. However, Eschenbrenner and Kausler (1968) obtained associative recall data suggesting the operation of a competition-unlearning component in the W_2-R_1 paradigm with W-R associations of the first list being less available than in the control groups, even though the net transfer effect was clearly positive. Kausler and Dean (1967) and Kanak and Dean (1969) however, found somewhat less positive transfer for the W_2-R_1 paradigm than for a group which continued practice on the same list (W_1-R_1, W_1-R_1). Although this effect was nonsignificant, the consistent ordering of the group means across experiments suggests a minor negative transfer effect from the W-R associative competition component. Nevertheless, Wallace et al. (1972) failed to observe retroactive interference in the W_2-R_1 paradigm in either relearning or associative recall tasks.

The W_1-R_1, W_2-R_2 paradigm. The available data concerning the components of transfer in the W_2-R_2 paradigm (Kanak & Curtis, 1970) coincide with the data and interpretation provided by McGovern (1964) concerning transfer components in the A-B, C-D paired-associate transfer paradigm. In the W_2-R_2 paradigm, it is assumed that first list and transfer list W and R items enter into associations with a common learning context as a form of incidental learning. Moreover, it is assumed that the first list context-item associations initially compete with the acquisition of the corresponding transfer list context-item associations and extinguish during the course of transfer list learning in a fashion comparable to the specific associations of the A-B, A-C paired-associate transfer paradigm. The retention data indicating less retention of first list items following W_2-R_2 learning than the appropriate control groups, (Kanak & Curtis, 1970) are in complete accord with this explanation as are more recent data from three experiments reported by Kanak, Cole and

Curtis (1972).

It should be noted that in addition to the negative component of transfer in the W_2-R_2 paradigm, that a positive learning to learn component has been indicated. Underwood, Shaughnessy and Zimmerman (1972b) have shown performance increments due to successive practice on lists conforming generally to the W_2-R_2 paradigm. These authors have also shown that lists having repeated W-items are learned faster as a function of having had prior experience with them.

Interlist association. The research dealing with VD transfer paradigms in which there exists W_1-W_2 or R_1-R_2 interlist relationships has paralleled the efforts in paired-associate transfer in attempting to derive primary laws of specific transfer. The Osgood (1949) analysis of transfer in paired-associate paradigms holding S_1-S_2 and for R_1-R_2 interlist similarity relationships has been extended by Kanak and Dean (1969) to include corresponding interlist relationships in VD transfer paradigms. These authors have described a transfer surface, the width of which represents the degree of associative relatedness between W-items of first and second lists while the length of the surface represents the degree of associative relatedness between R-items of the two lists. Predictions from the surface based on interacting positive sources of transfer from frequency cues and negative sources from incidentally learned competing W-R or R-W associations are: 1) When W-item associative relatedness is varied and R-items remain identical, positive transfer should result the magnitude increasing as W-item relatedness varies from neutrality, through degrees of associative relatedness to identity. 2) Negative transfer should occur when R-item associative relatedness is varied and W-items remain identical, with the magnitude decreasing as R-item relatedness increases. In general, Kanak and Dean (1969, Exp. I) obtained transfer data supporting deductions derived from the surface. Specifically, the first prediction generated by the surface was supported only as a descriptive principle, while the second prediction was more strongly supported. Furthermore, data obtained independently (Kausler & Dean, 1967) are generally in accord with the predictions from the VD transfer surface. Kanak and Dean (1969) concluded that frequency cues generally determine the direction of transfer while associative mechanisms account for the degree of transfer.

Corresponding vs. non-corresponding paradigms. Perhaps the most compelling evidence implicating the role of associative factors in VD transfer has been provided by the comparison of performance in corresponding (R and W pairings or their associates are maintained in the transfer list) and non-corresponding paradigms (R and W or their associates maintain the same function in the transfer list, but the words are re-paired). According to the frequency theory interpretation, there should be differential transfer list performance as a function of corresponding or non-corresponding pairings in a given transfer paradigm since the integrity of Rule application is maintained in both situations. An associative account, on the other hand, would predict interference from competing W-R and R-W associations under conditions of re-pairing and hence less positive transfer than corresponding pairings. Kanak and Dean (1969, Exp. II) observed that the re-pairing of items in the transfer list produced significant decrements in the magnitude of positive transfer, with the greatest decrement occurring in the paradigm containing identical

W and R interlist items; a condition most favorable for the application of requency Ruels. This result clearly implies support for the role of associative mechanisms. Wallace and Nappe (1971) and Wallace (1972), however, have proposed a liberalization of the counting rule postulate of frequency theory to explain the re-pairing decrement without the necessity of invoking the operation of associative processes. According to these authors, variability exists in the frequency differentials between pairs to be discriminated. Thus, it is reasoned that when re-pairing occurs relatively less frequent R-items may actually be re-paired with more frequent W-items (i.e., a Rule 2 situation) resulting in the noted decrement if the subject continues to respond in a Rule 1 manner. By repeating certain pairs more than others on a single study trial, Wallace and Nappe (1971) were able to systematically re-pair R-items with W-items possessing greater frequency and did demonstrate the performance decrement on a subsequent single test trial. Despite the interpretation of this decrement in terms of frequency, the greater repetition of some pairs relative to other pairs for purposes of producing frequency differences conceivably permitted the concomitant development of intrapair W-R associations which when these items were re-paired on the test trial may have in fact had the resultant effect of producing associative interference. If so, attribution of the decrement to frequency factors may be seriously questioned. Whether frequency factors alone can account for the decrement needs to be tested under conditions which clearly prevent the attribution of the effect to associative mechanisms.

Single list experiments in which constant pairing and random re-pairing from trial to trial are compared have yielded data indicating no performance decrement due to the re-pairing (Lovelace, 1968; Ullrich, 1972). These data have been interpreted as favorable to a frequency account of the re-pairing decrement. Nevertheless, the random re-pairing of R-items with other W-items from trial to trial in the variable pairing condition would not permit the formation of a stable W-R association (i.e., subject would see a given W-R pair only once during the session) and hence no decrement would be expected from an associative point of view. In order for a decrement to occur in the single list experiment, one would have to permit the repeated presentation of a given pair before the re-pairing was undertaken to insure that the W-R association was at or near asymptotic strength. It should be noted that while this theoretical conflict is not resolved, the onus of explaining the transfer data without reference to associative processes would seem to lie with frequency theory.

Reversed Item Function

In addition to the research conducted with the transfer paradigms considered to be analogous to the classical paired-associate transfer paradigms, a number of investigators have used the VD transfer task to study performance in partial and complete interlist item-function reversals. For the most part, the data yielded by these experiments have been interpreted in such a way as to implicate processes other than recognition memory in VD transfer. Indeed, most of the experiments reviewed in this section are similar to non-verbal discrimination reversal problems thought to require problem-solving and concept identification processes and have been conducted with the intent of clarifying how these processes are involved in VD transfer. For this reason, concepts divorced from frequency theory will be discussed.

Percentage of items reversed. When 100% reversal of item function occurs between two lists to be learned, initial positive transfer is observed followed on later trials by negative transfer (Raskin *et al.* (1968). This finding is perfectly consistent with the Rule-switch analysis of frequency theory given for the theoretically equivalent W_1-R_2 paradigm in a previous section. However, the preponderance of research involving item-function reversal has not been concerned with the measurement of specific transfer, but has been directed at delineating empirical relationships between performance and the percentage of items reversed. The relationships which have been derived are dependent upon whether total errors, trials to criterion, errors on reversed items or errors on non-reversed items are analyzed in the reversal task. First, the relationship between the percentage of items reversed (0%, 25%, 50%, 75% or 100%) and total errors in reversal is a nonmonotonic function reflecting maximum errors with 50% item-function reversal and more errors associated with 75% item reversal than with 25% item reversal (Paul, 1966; Paul, 1968). Secondly, the relationship between trials to reversal criterion and the percentage of items reversed is also a nonmonotonic function indicating greatest difficulty for 75% item reversal (Paul, 1968; Paul, Callahan, Mereness & Wilhelm, 1968). Finally, errors on reversed items decrease as the percentage of items reversed increases (Paul, 1966; Paul, 1968; Paul *et al.*, 1968) while errors on non-reversed items increase as the percentage of items reversed increases (Paul, 1966; Paul, 1968; Paul *et al.*, 1968).

While the frequency theory is capable of accounting for most of these data on the basis of frequency rule application, it is difficult within the frequency rubric to explain the general finding of poorer performance with 75% item reversal than for 25% item reversal (Paul et al., 1968). Since Rule 1 responding is as appropriate to the non-reversal items of the 25% reversal condition as Rule 2 responding is to the reversed items 75% reversal condition, one would expect no differences in performance as a functinn of these particular reversal manipulations. Nevertheless, the Rule 1 responding in the 25% reversal condition requires no shift in application for a majority of items between first and second lists while the 75% reversal condition requires a shift from Rule 1 responding in the first list to a Rule 2 mode of responding to a majority of items in the second list, conceivably resulting in the observed asymmetry. The data obtained by Kausler and Farzanegan (1969) indicating that the particular frequency rule activated during a first list task transfers to a subsequent task would appear to support such an analysis.

On the other hand, the notion of the transfer-activated response set advanced by Paul and Paul (1968) and extended by others to include the concept of acquired conditional equivalence (Paul, 1970; Paul & Callahan, 1972; Paul, Hoffman & Dick, 1970) incorporates the role of conceptual and problem-solving processes in VD reversal. Briefly these authors assume, generally, that the characteristics of the materials to be learned activate implicit cue-producing classificatory responses which mediate VD reversal. Specifically it is assumed that the nonreinforcement of an originally correct alternative in the reversal phase activates a set to suppress responding to the once correct alternative and that the suppression tendency generalizes to all the members of an equivalence class (i.e. all the formerly correct response alternatives). Paul et al. (1968) have inferred that the set operative in reversal tasks is indeed a suppression set and not a set to simply reverse the first list responses. They used a three alternative discrimination which prohibits the use of a general "reversal set" but permits the operation of a suppression set. Their results conformed to the empirical relationships derived from experiments using a two alternative discrimination and therefore seem to indicate the operation of a suppression set. This suppression set is optimal for the 100% reversal task and less than optimal for partial reversal tasks. The finding that 75% item reversal is generally a more difficult task than a 25% reversal condition suggests that the latter task does not have the necessary number of items reversed to activate the suppression set while the former task activates the suppression set and consequently interferes with the acquisition of non-reversed pairs in the second task.

The additional notion that R and W items come to constitute equivalence classes which form the basis for the operation of response-sets was supported by experiments conducted by Paul, Hoffman and Dick (1970). In these experiments, discriminative cues were introduced either in the transfer task (reversed and non-reversed pairs color coded) or during first list acquisition (subjects learned different labeling responses for reversed and non-reversed pairs) and served to differentiate reversed from non-reversed pairs. In both cases, the introduction of the cue facilitated performance in 50% reversal conditions relative to 50% reversal conditions not given the discriminative cue.

Despite interpretations of the relationships holding for various performance measures and the percentage of items reversed, the intriguing possibility exists that the perception of subjective frequency differences could provide the specific basis for the formation of equivalence classes which in turn form the basis for the use of response-sets in various types of reversal problems. While similar possibilities have been suggested by others (Paul & Paul, 1968; Paul *et al.*, 1968) there have been no explicit statements concerning the role of frequency in VD tasks presumably involving processes other than, or in addition to, recognition memory.

Overlearning and reversal performance. All the experiments concerned with determining the effects of post-criterion training upon reversal performance have uniformly indicated that 50% post-criterion training facilitates performance in partial and complete item reversals whether between-group (Paul, 1966; Paul, 1968; Paul & Callahan, 1972; Paul *et al.*, 1968) or within-subject designs are used (Paul & Callahan, Exp. IV, 1972). Paul and Callahan (1972) have proposed a differentiation-suppression hypothesis in which overtraining is assumed to increase the differentiation between W and R items so that the response-set to suppress first task R-items is made more reliable in the reversal phase. In addition to the mixed list experiment cited above, Paul and Callahan (1972) tested this hypothesis in three other experiments.

First, it was reasoned that if underlining the R-items in the reversal phase positively affected differentiation of R and W items that criterion trained subjects should perform as well as subjects given overtraining, while the absence of underlining should produce differences favoring the overtrained subjects. This prediction was supported in the form of an interaction which included the level of training and the underlining variable (Paul & Callahan, Exp. I, 1972). Secondly, the dual nature of the proposed hypothesis would appear to imply that the role of suppression becomes increasingly less important as the number of alternatives involved in the task increases. This is because with an increased number of alternatives the subject in reversal must still learn the R-item from the remaining W alternatives. As the number of W alternatives increases such learning increases in difficulty while suppression of the old R-item remains constant. In confirmation of this deduction Paul and Callahan (Exp. II, 1972), using a five-alternative reversal task, obtained no differences in errors or trials to reversal criterion as a function of the degree of training. Finally, since the differentiation between R and W items is crucial to the differentiation-suppression account of overtraining effects, it would appear to predict that overtraining should result in shift performance differences when old R-items are present in the shifted task, but not when old R-items are absent from the shifted task. Paul and Callahan (1972, Exp. III), using a shift from a three alternative VD list to a two alternative list in which the old R-item was either present or absent, also obtained confirmation of this deduction from the hypothesis.

Although the experiments reviewed here provide strong support for the differentiation-suppression hypothesis of overlearning effects in reversal paradigms, the frequency theory as extended by Wallace and Nappe (1971) would appear capable of accounting for these data without invoking the operation of various response sets. According to this extension, discussed earlier, overlearning should function to make the frequency differences favor all of the R-items of a list relative to criterion training thus facilitating subsequent discrimination on the basis of subjective frequency differences in the shifted task.

RETENTION

Like the research in VD acquisition and particularly in transfer, the experiments performed with the purpose of delineating processes in VD retention have been guided by frequency theory and the multiple-component-process extension to frequency theory. The first experiment reviewed here reflects both these influences while subsequent studies represent attempts to demonstrate the role of situational frequency in recognition memory and to broaden frequency theory to more adequately account for the forgetting of a verbal discrimination.

Associative factors. According to a literal interpretation of frequency theory, one should observe retroactive interference in the W_1-R_1, W_1-R_2 paradigm, but no proactive interference. The proactive effects would not be expected because the frequency differentials between W_1 and R_2 items formed during second list practice would presumably be present at the time of a retention test. On the other hand, retroactive interference would be expected since the accrual of frequency units to W_1 items during second list learning would theoretically function to decrease the frequency differential between W_1 and R_1 items causing errors in a retention test of the first list. Ekstrand et al., (1966) also suggest that forgetting should not occur over time, provided the frequency differential is not reduced through the exposure of list materials during the retention interval. However, if incidentally learned associations are involved in retention, proactive as well as retroactive interference should be observed. Moreover, because spontaneous recovery of first list intrapair associations would also be expected, there would be an inverse relationship between the amount of retroactive interference and the length of the retention interval and a direct relationship between the amount of proactive interference and the length of the retention interval. In a test of these predictions, Eschenbrenner (1969) obtained data from associative recall and relearning tasks which generally tend to support the proposition that associative factors operate to produce forgetting in the W_1-R_2 paradigm. However, this conclusion, while entirely appropriate with respect to the predictions concerning retroactive interference is not entirely justified in view of his failure to observe proactive interference at any retention interval (1 min., 25 min. or 48 hr.). Other investigators have not been concerned with the empirical establishment of associative processes in VD retention, but have directed their efforts at implicating the role of frequency in recognition memory.

Frequency. Underwood and Freund (1968b) tested the proposition that the discrimination of situational frequency is necessary for recognition by giving subjects a single trial in which to study and pronounce a list of 40 words which appeared subsequently in a recognition task paired with either high word-associates, formally similar words, or neutral words. In addition, some subjects were required to pronounce either associates, formally similar words, or neutral words during the study trial, but were instructed to remember only the target words. Recognition tests were given immediately or 24 hr. after the study trial. According to these authors, the inclusion of a high word-associate with the target word in the recognition task should produce errors because of a reduction in situational frequency differences due to the elicitation of an IAR. Furthermore, the pronunciation of other words in the study trial should also serve to equate situational frequency and reduce effective recognition. In their analysis of the nature of errors in recognition, Underwood & Freund (1968b) found the presence of a word-associate in the recognition phase hindered recognition regardless of whether it appeared during the study trial, while formal similarity interfered with recognition only when pronunciation of the formally similar words was required in study. These authors also observed a decrement in recognition as a function of the retention interval and attributed this forgetting to the gradual assimilation of specific situational frequency into background frequency. Supposedly the better recognition (Erlebacher, Hill & Wallace, 1967) and recall (Zechmeister & Underwood, 1969) of R-items results from the greater accrual of situational frequency to the R-items during acquisition, relative to W-items, making them easier to retain.

To more adequately account for forgetting in VD learning a frequency-assimilation hypothesis has recently been advanced (Underwood & Freund, 1970b). This hypothesis holds that frequency produced experimentally (situational frequency) begins to merge with pre-experimental frequency (background frequency) with the passage of time to produce decrements in retention. Basic tests of deductions from the frequency-assimilation hypothesis of forgetting have been undertaken in experiments employing traditional retention tasks (Underwood & Freund, 1970b) and in an experiment using comparative judgments of frequency (Underwood, Zimmerman & Freund, 1971). Underwood and Freund (1970b, Exp. I) have reasoned that if two words in a pair come from different background frequencies, that less forgetting should occur when the high-frequency member is designated as correct than when the low-frequency member is designated as correct and that the magnitude of this difference should increase as the length of the retention interval increases. Furthermore, they reasoned that once the minimum frequency differential necessary for discrimination is achieved that the degree of original learning should have no effect on retention. The data yielded by recall, relearning and matching tests administered after the acquisition of a single 42-pair list were highly consistent with these expectations. Secondly, Underwood and Freund (1970b, Exp. II) varied the number of interpolated learning trials on a reversal list and assumed that retroactive interference would be maximal when the number of trials in original learning and interpolated learning were equivalent with the further expectation that the retroactive effects would diminish as the number of trials on the interpolated task increased relative to the number of trials given on the original task. Proactive interference was also assessed as a function of the number of trials given on an interpolated reversal task with trials on the original task held constant. The frequency account would predict that proactive interference should decrease as the degree of interpolated practice increases. The expectations regarding retroactive interference were generally supported by the recall and relearning data obtained by Underwood and Freund (1970b), while, despite the observation of proactive interference and an effect due to the number of learning trials, no interaction of paradigm with number of interpolated learning trials was obtained. In yet another test of the frequency-assimilation hypothesis, Underwood, Zimmerman and Freund, (1971) required the comparative judgment of frequency of six word-pairs possessing identical situational frequency and different backgroundfrequency. It was expected that as the retention interval increased (immediate, 1 day or 7 days) that the frequency with which subjects chose the member possessing the higher background frequency would also increase. Nevertheless, their data indicated no change in judgment across retention intervals.

Two problems for the frequency-assimilation hypothesis and a frequency account of forgetting in general, are identifiable from an inspection of the data. First, the data obtained from experiments employing traditional retention measures (Underwood & Freund, 1970b) generally conform to deductions from the frequency-assimilation hypothesis while the data obtained from the experiment requiring the comparative judgment of frequency (Underwood, et al., 1971) do not. This would seem to indicate that factors other than frequency, or in combination with frequency, operate to produce the relationships expected on the basis of frequency alone. Since there is ample data indicating that situational frequency is a dominant factor in recognition memory, the conservative evaluation of this discrepancy would be that factors operate in combination with frequency to produce forgetting. The more extreme alternative would require the complete rejection of the frequency-assimilation hypothesis.

The second problem involves the frequency account of performance in interpolated reversal learning and the relearning of an initially learned list. Frequency theory would predict a deterioration of performance due to the equalization of frequency differences during the course of these tasks. However, this decrement has not been observed in the experiments utilizing reversal and relearning procedures (Underwood & Freund, 1970b; Underwood, Shaughnessy & Zimmerman, 1972). While this problem is perplexing to proponents of frequency theory, a possible resolution of the problem is suggested in an hypothesis advanced by Hintzman and Block (1971). These authors have shown that frequency information can be specific to a certain context and have hypothesized that the failure to observe performance decrements as a function of theoretical rule shifts is due to this specificity of frequency information. Thus according to this reasoning, the frequency information gained in a transfer task would be considered discriminatively different from the corresponding information gained in a previous task.

While all of the explanatory concepts discussed within this section are partially supported by data, it does not appear that any of them taken singly are entirely satisfactory to account for the forgetting of a verbal discrimination. Certainly a more compelling account should include provisions for the operation of frequency, associative factors, and concepts which provide for the loss of frequency information with the passage of time. Both the multiple-component analysis and the frequency-assimilation accounts of forgetting are presently inadequate because neither appear capable of clearly specifying how frequency information is lost, if indeed frequency information is the basis for original discrimination.

CONCLUSIONS

The general impression one obtains from a survey of the VD acquisition, transfer and retention data is, first, that the perception of subjective frequency differences is undoubtedly involved in certain VD problems, but that other processes and list attributes come to influence discrimination in some situations, notably transfer tasks, reversal problems, and retention of discriminations. It does appear that if no other cue is available to mediate discrimination that frequency information comes to be relied upon for task solution. From the standpoint of evaluating the status of frequency theory, the data reviewed here would seem to demand that certain theoretical limits be specified. Our interpretation of the frequency theory is that it is primarily a theory of rote verbal discrimination. This interpretation implies that predictions from frequency theory should be expected to hold only in those acquisition, transfer and retention problems wherein no processes other than recognition memory are possible. Hence VD tasks which provide cues for the use of higher-order processes (i.e. organization, use of strategies, concept identification) conceivably yield data which lie beyond the scope of frequency theory. Nevertheless, despite its apparent failures, the frequency theory has immeasureably affected the direction of research in VD learning and without it we might not be albe to reach the rather innocuous conclusions reached above. The general impression of frequency theory held by the present authors are appropriately expressed by the following comments of Tulving and Madigan (1970):

> "The Frequency Theory of verbal discrimination is wrong, in the same sense that all extant theories in our field are wrong: Ten years from now, or a hundred years, or a thousand years, students of memory will look at it in the same way as we regard the attempts of the ancient Greeks to explain the composition of the universe in terms of four basic elements. But at the present time, the Frequency Theory must be counted among the few genuine theories we have. It does explain data from a number of experiments, it does make specific predictions about outcomes of as yet undone experiments, it does deal with important fundamental processes in learning and memory, and it is specific enough so that it is capable of being proved wrong. Because of these outstanding characteristics that distinguish it from many other collections of speculations referred to as 'theories', we predict that it will receive a lot of attention, will generate a lot of research, and will be hotly debated at least over the foreseeable future." (pp. 455 and 456)

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APPENDIX B

WORD LISTS

Word List-A First Serial Order

1. JOURNAL
2. HEAVEN
3. PEACE
4. SOLDIER
5. OFFICE
6. FLOOR
7. BOAT
8. KITCHEN
9. MONEY
10. STREET
11. DOCTOR
12. MARKET
13. GLASS
14. PICTURE
15. PEACE
16. STREET
17. HISTORY
18. OFFICE
19. DOCTOR
20. LEADER
21. DREAM
22. RECORD
23. SOLDIER
24. GLASS
25. JOURNAL
26. BOAT
27. MONEY
28. MARKET
29. PEACE
30. HEAVEN
31. SOLDIER
32. PICTURE
33. GLASS
34. HISTORY
35. BOAT
36. JOURNAL
37. STREET
38. RECORD
39. OFFICE
40. LEADER
41. PEACE
42. HISTORY
43. STREET
44. SOLDIER
45. MONEY
46. HEAVEN
47. MARKET
48. GLASS
49. RECORD
50. BOAT
51. DREAM
52. STREET
53. FLOOR
54. MARKET
55. BOAT
56. JOURNAL
57. MONEY
58. PEACE
59. OFFICE
60. STREET
61. KITCHEN
62. RECORD
63. JOURNAL
64. OFFICE
65. HEAVEN
66. MARKET
67. HISTORY
68. PEACE
69. BOAT
70. JOURNAL
71. OFFICE
72. MARKET

Word List-A Second Serial Order

1. OFFICE
2. BOAT
3. MONEY
4. LEADER
5. GLASS
6. MARKET
7. HEAVEN
8. STREET
9. PEACE
10. OFFICE
11. MONEY
12. HISTORY
13. SOLDIER
14. MARKET
15. JOURNAL
16. DREAM
17. DOCTOR
18. HISTORY
19. BOAT
20. STREET
21. HEAVEN
22. KITCHEN
23. PICTURE
24. GLASS
25. MONEY
26. DREAM
27. OFFICE
28. PEACE
29. HISTORY
30. FLOOR
31. STREET
32. JOURNAL
33. BOAT
34. MARKET
35. OFFICE
36. KITCHEN
37. HISTORY
38. PEACE
39. SOLDIER
40. RECORD
41. GLASS
42. STREET
43. MARKET
44. BOAT
45. SOLDIER
46. JOURNAL
47. PEACE
48. HEAVEN
49. DOCTOR
50. RECORD
51. MARKET
52. OFFICE
53. BOAT
54. SOLDIER
55. JOURNAL
56. LEADER
57. RECORD
58. HEAVEN
59. OFFICE
60. PEACE
61. MARKET
62. STREET
63. PICTURE
64. JOURNAL
65. GLASS
66. PEACE
67. BOAT
68. MONEY
69. STREET
70. RECORD
71. JOURNAL
72. FLOOR

Word List-B First Serial Order

1. WATER
2. NUMBER
3. TABLE
4. WINDOW
5. BANK
6. MACHINE
7. CLOUD
8. MOUTH
9. ENEMY
10. SMOKE
11. SIGN
12. INCH
13. WATER
14. NIGHT
15. JUDGE
16. SONG
17. FARMER
18. ENEMY
19. WINDOW
20. ANIMAL
21. BANK
22. MACHINE
23. SIGN
24. INCH
25. APPLE
26. TABLE
27. MOUTH
28. CLOUD
29. MACHINE
30. WATER
31. NIGHT
32. NUMBER
33. SONG
34. INCH
35. ENEMY
36. JUDGE
37. MACHINE
38. TABLE
39. FARMER
40. CLOUD
41. APPLE
42. NIGHT
43. WINDOW
44. BANK
45. WATER
46. INCH
47. SIGN
48. MOUTH
49. MACHINE
50. ANIMAL
51. CLOUD
52. ENEMY
53. WATER
54. NUMBER
55. INCH
56. TABLE
57. BANK
58. WINDOW
59. SIGN
60. CLOUD
61. SMOKE
62. ENEMY
63. NIGHT
64. BANK
65. INCH
66. WATER
67. MACHINE
68. NUMBER
69. CLOUD
70. MOUTH
71. ENEMY
72. BANK

Word List-B Second Serial Order

1. NIGHT
2. INCH
3. MACHINE
4. BANK
5. ENEMY
6. MOUTH
7. WATER
8. NUMBER
9. TABLE
10. WINDOW
11. MACHINE
12. INCH
13. SIGN
14. SMOKE
15. CLOUD
16. SONG
17. BANK
18. JUDGE
19. WATER
20. ENEMY
21. APPLE
22. TABLE
23. INCH
24. ANIMAL
25. CLOUD
26. SIGN
27. MACHINE
28. NUMBER
29. WATER
30. NIGHT
31. BANK
32. FARMER
33. MOUTH
34. INCH
35. TABLE
36. CLOUD
37. WINDOW
38. ANIMAL
39. ENEMY
40. BANK
41. MACHINE
42. WATER
43. CLOUD
44. SONG
45. FARMER
46. NIGHT
47. INCH
48. JUDGE
49. NUMBER
50. MOUTH
51. WINDOW
52. SMOKE
53. ENEMY
54. CLOUD
55. MACHINE
56. SIGN
57. WATER
58. NIGHT
59. BANK
60. WINDOW
61. ENEMY
62. APPLE
63. TABLE
64. MOUTH
65. CLOUD
66. MACHINE
67. SIGN
68. BANK
69. NUMBER
70. WATER
71. INCH
72. ENEMY

APPENDIX C

COMPARATIVE JUDGMENT TASKS

Comparative Judgment Task List-A

BOAT MONEY	1 2 3 4 5
DOCTOR GLASS	1 2 3 4 5
FLOOR OCEAN	1 2 3 4 5
JOURNAL LEADER	1 2 3 4 5
SHOE STREET	1 2 3 4 5
HISTORY MARKET	1 2 3 4 5
WEATHER RECORD	1 2 3 4 5
HEAVEN DREAM	1 2 3 4 5
KITCHEN PATH	1 2 3 4 5
PICTURE PEACE	1 2 3 4 5
SOLDIER HOUSE	1 2 3 4 5
PAPER OFFICE	1 2 3 4 5

Comparative Judgment Task List-B

APPLE WATER	1 2 3 4 5
HILL SONG	1 2 3 4 5
JUDGE WINDOW	1 2 3 4 5
MACHINE NUMBER	1 2 3 4 5
NIGHT GATE	1 2 3 4 5
FARMER COURT	1 2 3 4 5
COST INCH	1 2 3 4 5
ANIMAL TABLE	1 2 3 4 5
BANK MOUTH	1 2 3 4 5
SIGN BLOOD	1 2 3 4 5
SMOKE ENEMY	1 2 3 4 5
CLOUD BABY	1 2 3 4 5

APPENDIX D

ABSOLUTE JUDGMENT TASKS

Absolute Judgment Task List-A

BOAT	______	1 2 3 4 5	HISTORY	______	1 2 3 4 5
MONEY	______	1 2 3 4 5	MARKET	______	1 2 3 4 5
DOCTOR	______	1 2 3 4 5	WEATHER	______	1 2 3 4 5
GLASS	______	1 2 3 4 5	RECORD	______	1 2 3 4 5
FLOOR	______	1 2 3 4 5	HEAVEN	______	1 2 3 4 5
OCEAN	______	1 2 3 4 5	DREAM	______	1 2 3 4 5
JOURNAL	______	1 2 3 4 5	KITCHEN	______	1 2 3 4 5
LEADER	______	1 2 3 4 5	PATH	______	1 2 3 4 5
SHOE	______	1 2 3 4 5	PICTURE	______	1 2 3 4 5
STREET	______	1 2 3 4 5	PEACE	______	1 2 3 4 5
SOLDIER	______	1 2 3 4 5	HOUSE	______	1 2 3 4 5
PAPER	______	1 2 3 4 5	OFFICE	______	1 2 3 4 5

Absolute Judgment Task List-B

APPLE	______	1 2 3 4 5	FARMER	______	1 2 3 4 5
WATER	______	1 2 3 4 5	COURT	______	1 2 3 4 5
HILL	______	1 2 3 4 5	COST	______	1 2 3 4 5
SONG	______	1 2 3 4 5	INCH	______	1 2 3 4 5
JUDGE	______	1 2 3 4 5	ANIMAL	______	1 2 3 4 5
WINDOW	______	1 2 3 4 5	TABLE	______	1 2 3 4 5
MACHINE	______	1 2 3 4 5	BANK	______	1 2 3 4 5
NUMBER	______	1 2 3 4 5	MOUTH	______	1 2 3 4 5
NIGHT	______	1 2 3 4 5	SIGN	______	1 2 3 4 5
GATE	______	1 2 3 4 5	BLOOD	______	1 2 3 4 5
SMOKE	______	1 2 3 4 5	ENEMY	______	1 2 3 4 5
CLOUD	______	1 2 3 4 5	BABY	______	1 2 3 4 5

APPENDIX E

INSTRUCTIONS

INSTRUCTIONS

List Instructions

I am going to show you a list of common English words which will appear one at a time in the window of the memory drum (pointing). I would like for you to pronounce each word as it appears. Some of the words in the list occur more than one time, but I would like for you to pronounce them anyway. Your task will be to try and remember the words in this list, not in any particular order, but just try to remember them. (For Ss who viewed two lists, essentially the same instructions were used to introduce the second list.)

Neutral Task Instructions

This is a number cancellation task (pointing to the sheet of numbers). I am going to give you a number in a moment and I want you to cancel out that particular number throughout the entire page. When you are satisfied that you have marked out all of the occurrences of the number I have given you, tell me and I may or may not give you another number to begin cancelling... Begin marking out all of the (sixes) .

Comparative Judgment Instructions

Here are pairs of words which appeared in the list that was shown to you (in the case of experimental groups, Ss were told that the words were from only one of the lists that they were shown). I want you to look at each pair of words and circle the one in the pair which you think occurred more often. After you have circled one of the words, proceed to the numbers and circle one of them. The number that you circle will indicate how sure you are of your choice. If you circle a five, that means that you are absolutely certain that the word you circled occurred more often. If you circle a one, it means that you are absolutely uncertain and that you just guessed. Two, three and four represent varying degrees of sureness in between these two extremes. Proceed in this manner down the page until you have completed the last pair. Tell me when you are finished.

Absolute Judgment Instructions

On this sheet of paper are words which came from the list that was shown to you (in the case of experimental groups, *Ss* were told that the words were from *only* one of the lists that they were shown). I want you to look at each word and in the space provided next to each word write in a number indicating how often you think that particular word occurred. After you have written in how many times you think the word occurred, proceed to the numbers and circle one of them. The number you circle will indicate how sure you are of your judgment. If you circle a five, that means that you are absolutely certain that the number you have written in the space is correct. If you circle a one, it means that you are absolutely uncertain and that you have no idea how many times the word occurred. Two, three and four represent varying degrees of sureness in between these extremes. Proceed in this manner down the page, looking at only one word at a time, until you have completed the last word. (At this point, *Ss* were instructed in the use of the special cover sheet which was used in the absolute judgment task).

APPENDIX F

SUMMARIES FOR ANALYSES OF VARIANCE

Summary of (RI vs PI x Experimental vs Control x

Presentation Context x Judgment Context)

Analysis of Variance on Errors in

Comparative Frequency Judgment

Source	MS	df	F	P
Total	1.315	191		
Between	2.736	15		
A (RI vs PI)	1.507	1	1.262	.2620
B (Exp. vs Control)	29.298	1	24.545	.0011**
C (Presentation Context)	.049	1	.041	.8348
D (Judgment Context)	.882	1	.738	.6044
AB	.629	1	.526	.5241
AC	.879	1	.736	.6035
AD	.129	1	.107	.7424
BC	.879	1	.736	.6035
BD	.003	1	.003	.9559
CD	.003	1	.003	.9559
ABC	1.173	1	.983	.6763
ABD	.048	1	.040	.8354
ACD	3.798	1	3.182	.0725
BCD	.882	1	.739	.6044
ABCD	.879	1	.737	.6037
Within	1.194	176		

Summary of (RI vs PI x Experimental vs Control x

Presentation Context x Judgment Context)

Analysis of Variance on Confidence Ratings

in Comparative Frequency Judgment

Source	MS	df	F	P
Total	.289	191		
Between	.472	15		
A (RI vs PI)	.111	1	.408	.5311
B (Exp. vs Control)	3.820	1	13.998	.0005**
C (Presentation Context)	.340	1	1.245	.2651
D (Judgment Context)	.018	1	.064	.7957
AB	.563	1	2.061	.1419
AC	.343	1	1.256	.2630
AD	.053	1	.193	.6651
BC	.053	1	.193	.6651
BD	.396	1	1.449	.2282
CD	.088	1	.322	.5781
ABC	.117	1	.429	.5203
ABD	.015	1	.054	.8120
ACD	.466	1	1.707	.1900
BCD	.442	1	1.621	.2018
ABCD	.255	1	.934	.6633
Within	.273	176		

Summary of (RI vs PI x Experimental vs Control x

Presentation Context x Judgment Context)

Analysis of Variance on Absolute Deviations

in Absolute Frequency Judgment

Source	MS	df	F	P
Total	55.088	191		
Between	147.716	15		
A (RI vs PI)	1.125	1	.024	.8721
B (Exp. vs Control)	1261.126	1	26.722	.0001**
C (Presentation Context)	2.109	1	.045	.8273
D (Judgment Context)	.891	1	.019	.8860
AB	1.266	1	.027	.8645
AC	107.578	1	2.279	.1289
AD	126.328	1	2.676	.0996
BC	60.281	1	1.277	.2588
BD	84.938	1	1.799	.1781
CD	247.078	1	5.235	.0219**
ABC	42.609	1	.903	.6547
ABD	6.469	1	.137	.7130
ACD	3.422	1	.072	.7844
BCD	261.750	1	5.546	.0185**
ABCD	8.766	1	.185	.6710
Within	47.193	176		